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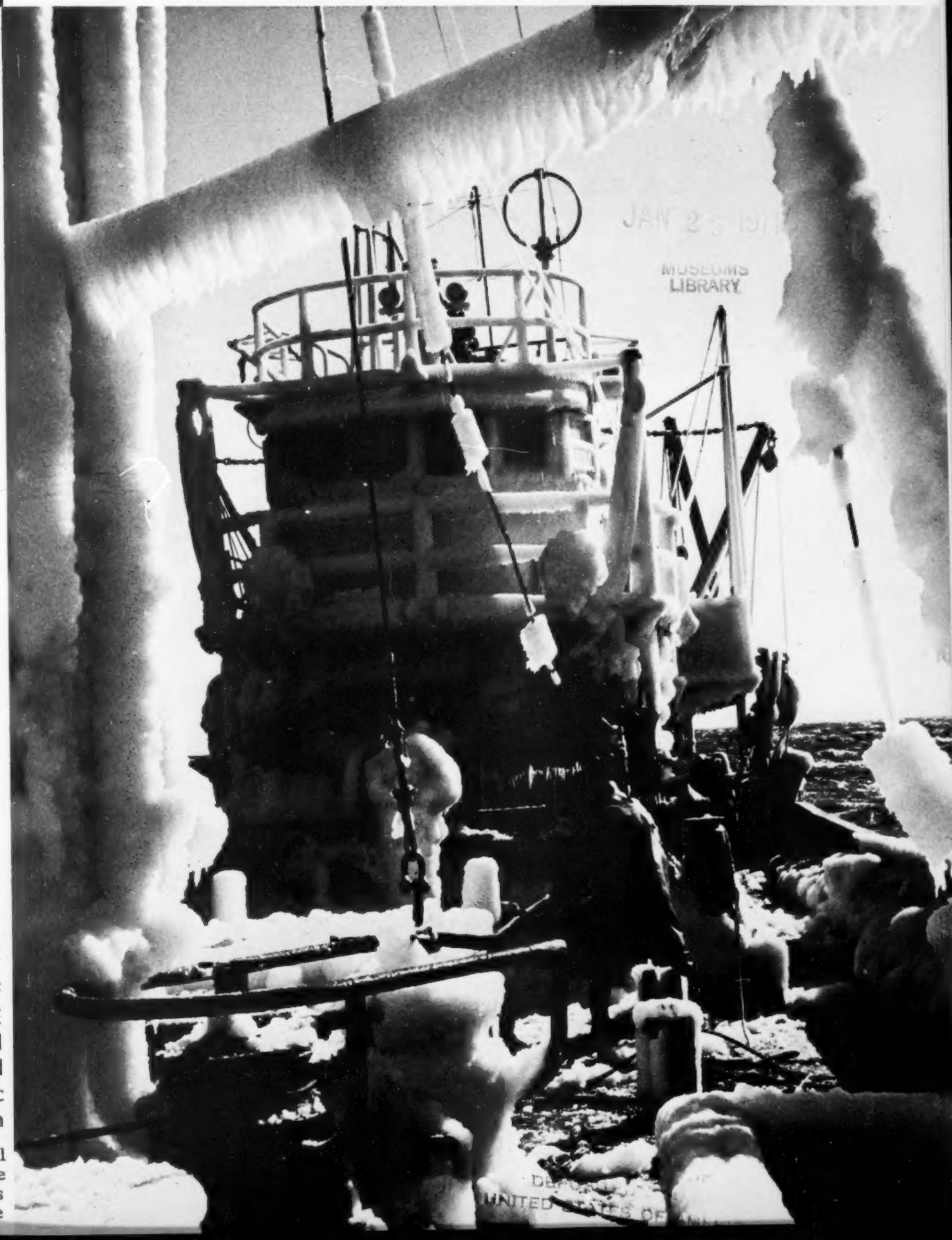

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

National Marine Fisheries Service

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Dr. Robert M. White, Acting Administrator

NATIONAL MARINE FISHERIES SERVICE
Philip M. Roedel, Director

COVER: Iced-up Gloucester trawler. (Warren F. Rathjen)

COMMERCIAL FISHERIES

Review

A comprehensive view of United States and foreign fishing industries--including catch, processing, marketing, research, and legislation--prepared by the National Marine Fisheries Service (formerly Bureau of Commercial Fisheries).

FISHERMEN'S MEMORIAL--GLOUCESTER, MASS.

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Throughout this book, the initials NMFS stand for the NATIONAL MARINE FISHERIES SERVICE, part of NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), U.S. Department of Commerce.

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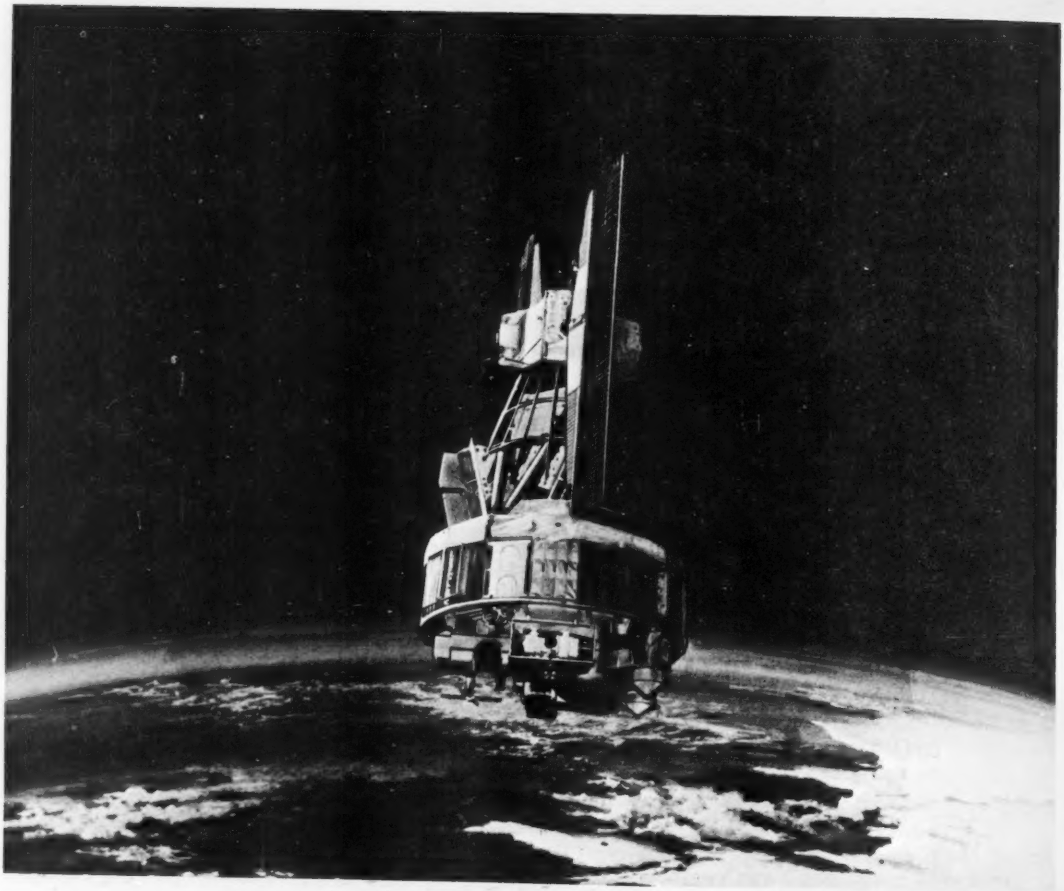


Nimbus (Photo: NOAA)

U.S. & CALIFORNIA MODERNIZE A FISHING OPERATION

Machines may replace men on the boats that fish mackerel, anchovy, and bonito out of San Pedro, Calif., if an experiment to mechanize wetfish purse-seining is successful. This is reported by Izadore Barrett, Acting Director of the National Marine Fisheries Service (NMFS) laboratory in La Jolla.

The experiment, begun in summer 1970, is sponsored jointly by NMFS and the California Marine Research Committee (MRC). It involves the 83-foot fishing vessel 'Sunset', reactivated after long idleness by its new skipper, Nick Jurlin of San Pedro.

Sunset Changes

Among the fishing improvements installed on Sunset by NMFS and MRC are a hydraulically driven net drum that winds up the large purse seine; before, it took half the crew to stack it on the stern. Another is an improved pursing winch that closes the bottom of the net and neatly stores its lines. A pump that sucks up the fish concentrated in the pursed net has replaced the laborious dip-net operation. With these and other improvements, Sunset has been operating with only 5 men, instead of the usual 10.

Effects on Crew

Mr. Barrett explained that in a fishery topheavy with underpaid manpower, crew reductions that maintain equal, or produce greater, catching efficiency benefit owner and crew. The loss of jobs in the wetfish fleet as a result of such technological improvements can be absorbed by natural attrition, while the remaining higher-paying jobs will emphasize the essential skills of commercial fishing without the drudgery. A study by NMFS fishery biologists and economists has shown that the boat owner can pay off the cost of mechanization in 5 years--and should even make higher profits during this period.

At last reports, Sunset, fishing with a reduced crew, was a "high-liner" (a leader) among 21 boats fishing for anchovy. Results are being watched carefully.

Mr. Barrett notes that several boats have begun to instal fish pumps in what may be the first steps toward modernizing the San Pedro wetfish fleet.

U.S. WEATHER SATELLITES AID FISHERMEN

With the help of scientists at NMFS La Jolla (Calif.) laboratory, U.S. tuna fishermen now have an eye in the sky to warn them of impending storms and rough seas that affect fishing. In July 1970, an automatic picture-transmission (APT) satellite receiver was installed in lab to provide detailed photographs of weather patterns over fishing grounds. This information is transmitted from three U.S. weather satellites--NIMBUS IV, ESSA-8, and ITOS-1--as they move through sky in orbits covering principal tuna grounds from Pacific Northwest to eastern tropical Pacific.

Improve Fishery Advisories

Using the satellite photographs, Dr. Nathan Clark, Meteorologist, and James Renner, Fishery Biologist, have been able to improve accuracy of weather forecasts presented in fishery advisories. The advisories have been issued for the past 3 years, mainly for albacore fishermen. Forrest Miller, Meteorologist with Inter-American Tropical Tuna Commission, working under contract to NMFS, also uses satellite photographs to inform fishermen via radio of location, intensity, and movement of intertropical convergence zone and tropical storms.

New Research Project

Encouraged by APT's usefulness to influence fishing strategy, a new research project has begun at NMFS La Jolla to obtain direct readout of thermal infrared data from APT system--and to relate this information to sea-surface temperature patterns and gradients along Baja California and eastern tropical

Pacific. Dr. R. Michael Laurs, Leader of Fishery-Oceanography Group, is in charge.

How La Jolla Helps Fishermen

APT project is latest La Jolla effort to help U.S. fishermen catch more fish. La Jolla provides fishery advisories to albacore fishery off the West Coast, and to tropical tuna fleet west of Mexico and Central America. These advisories, said Izadore Barrett, Acting Director, consist of daily forecasts of weather and sea-surface conditions for specific fishing grounds. There is special emphasis on surface winds, sea temperatures, and sea state as these relate to special needs of tuna fishermen. The advisories also contain marine weather forecasts based on information from National Weather Service and Navy's Fleet Numerical Weather Central. Information on daily albacore catches is included.

BOTTOM-FISH DISTRIBUTION AFFECTED LITTLE BY TEMPERATURE CHANGES

Temperature changes over the past 20 years have had little effect on the distribution of bottom fish on the continental shelf between Nova Scotia and Long Island. So reports NMFS Woods Hole (Mass.) Laboratory. Its study of research-vessel distributional data and recent temperature trends did not show any important correlation.

Four key species were studied: American plaice, haddock, yellowtail flounder, and butterfish.

Temperatures Up Since 1957

Water temperature increased from the early 1940s to a maximum in 1952-53. Then temperatures declined through 1957. Since 1957, temperatures have trended upward. The effect of these changes on abundance of groundfish has not yet been examined.

CATFISH FARMING GROWTH CITED IN NMFS STUDY

The U.S. production of farm-reared channel catfish is expected to double within the next few years. This forecast is contained in NMFS study, "A Program of Research for the Catfish Farming Industry," conducted for Economic Development Administration (EDA) of Commerce Department.

The forecast is based on estimate of 22 million pounds of catfish produced in 1968 on 25,000 acres of water.

Industry Potential

The report states that the industry has the capacity to strengthen and diversify the economy of the southcentral States, where it is concentrated. Orderly growth of the industry, however, depends on expansion of markets and construction of processing plants to handle anticipated increased production.

The report reviews harvesting and processing techniques. It notes that mechanical harvesting units and skinning machines are being used.

NMFS & EDA Aid Industry

The technical assistance program for catfish industry is being continued by NMFS with EDA financial aid. The Catfish Farmers of America, a trade group, has requested EDA to help develop the industry.

A copy of the report may be obtained from U. S. Department of Commerce, Economic Development Administration, Publications Division, Washington, D.C. 20230.

A NEW DEVICE SUCCESSFULLY TESTS NUTRIENT VALUE OF FISH FEEDS

A "fish nutrient chamber," a plastic bottle-type device, has tested successfully the nutrient value of fish feeds. The work was done by researchers of Interior Department's Bureau of Sport Fisheries & Wildlife.

The chamber holds a fish and allows oxygenated water and nutrients to enter at one end; at the other end, fish wastes exit with

water. The researchers can determine closely how much fish growth results from various kinds and quantities of feed.

Much of the research has involved rainbow trout, but it is believed that such other species as salmon and catfish can be used.

RAPID SALTING PROCESS DEVELOPED

Whiting can be salted, dried, and packaged in one day using a new process developed at NMFS Gloucester (Mass.) Fishery Products Technology Laboratory. The usual salting and drying process takes weeks to months.

The salted whiting was prepared in a few minutes for use in a fish cake mix. When taste-tested, the fish cakes were very acceptable.

Another positive feature of the salted fish is that it is stable. It retains good color, odor, flavor, and texture after more than a month's storage at 80° F.

More information willl be made available after a patent has been granted.

NEW SELF-DESTRUCT PLASTIC MAY BE PACKAGING MATERIAL

A new packaging plastic has been developed in Sweden. Reportedly, it will keep its strength as long as needed, but it will decompose after use. It is a chemically modified polyethylene with some additives, which give it strength--but will accelerate decomposition when exposed to sunlight.

For Wrapping & Packaging

The makers hope the new plastic will be adapted for use as container wrapping and packaging materials. For information: Tetra Pak, of Raabyholms, Alle, Lund, Sweden. ('Air Cargo', Nov. 1970.)

MERCURY FOUND IN FUR SEALS

Scientists of NMFS Marine Mammal Biological Laboratory in Seattle have found high concentrations of mercury in the livers of northern fur seals (Callorhinus ursinus) collected in 1970.

Mercury in liver samples ranged from 0.05 to 0.35 ppm in ten 3-month-old pups taken on St. Paul Island, Alaska; from 3.0 to 19.0 ppm in 29 young males ages 2 and 3 years taken on St. Paul Island; and from 19.0 to 172.0 ppm in 29 adult females ages 5-19 years taken off Washington State.

Age A Factor

The data indicate higher concentrations are associated with age. Among adult females, the youngest had the lowest concentration, and the oldest had the highest concentration of mercury. The source of mercury is not known, nor the possible effects on fur seals understood.

--Ray Anas

ARMY VETOES DREDGING PROPOSALS IN FLORIDA WATERS

The Secretary of the Army has upheld a recommendation by the Army Corps of Engineers that developers of Honeymoon Island in Pinellas County, Florida, be denied a permit for dredging and filling. The developers sought to dredge 9 million cubic yards of fill material from Gulf of Mexico to create a 120-acre enlargement of Honeymoon Island in Gulf of Mexico opposite City of Dunedin.

The Secretary's Statement

The Secretary said the work would not be in the public interest: "After thorough consideration of all facts of the case and close analysis of the views of responsible local, state and federal officials and agencies, there appears to be little justification for allowing a major alteration of the Florida coastline, with the resultant irretrievable damage to the environment and to fish and wildlife. The esthetic and environmental aspects of developing the shoreline of the Florida coast with

non-water-oriented facilities creates in the Department of the Army's view an unfortunate and undesirable reduction in natural shore conditions which cannot be considered to be in the genral public interest."

U.S.-STATE PROGRAM TO RESTORE SHAD TO CONNECTICUT RIVER

Juvenile shad resulting from the $3\frac{1}{2}$ million fertilized eggs planted in Spring 1970 by Interior Department's Bureau of Sport Fisheries and Wildlife in Connecticut River were being studied for growth and survival during their downstream migration in Fall 1970.

The upstream parts of the river have been closed to shad for more than 100 years because of high dams. A cooperative Federal-State restoration program is trying to restore runs to river's lower parts and tributaries.

1970 OREGON SHRIMP HARVEST IS STATE RECORD

A record catch of at least 13.3 million pounds of shrimp has been landed at Oregon ports in 1970, according to Jack Robinson, Fish Commission biologist. The total should reach 13.5 million pounds when all figures are in. The fishing season closed October 31. For the past 3 years, landings were about 10 million pounds. Dockside value to Oregon fishermen will top $1.5 million.

The Fishery

The Oregon shrimp-fishing industry began only 13 years ago with 6 boats; now it has 56. Shrimp boats, mainly oceangoing trawlers, range from 45 to 85 feet. When not shrimping, these boats fish tuna, bottom fish, crabs, and salmon.

Shrimp are caught with modified otter trawls--big nets with one end opened like a gaping mouth 4 feet high by 40 feet wide and tapering to a small closed end. The trawl is dragged along bottom, scooping up and trapping the shrimp in its narrow end. The net, constructed of $1\frac{1}{4}$-inch nylon mesh, catches commercial-size shrimp--but allows small shrimp to escape.

How Ports Ranked

Coos Bay landings totaled 4,680,000 pounds. Newport was second with 2,945,000 pounds and may top 3,000,000 pounds. Astoria-Warrenton reported over 2,600,000 pounds, and Garibaldi 1,340,000 pounds. Port Orford, which landed 74,000 pounds in 1969, made a major comeback with 1,205,000 pounds. Brookings, the southernmost port in Oregon, reported 520,000 pounds.

1971 Prospects Bright

The record 1970 catch contributes significantly to the state's economy. According to Robinson, the prospects for 1971 appear bright. The strong 1968-69 year-classes should contribute excellent-sized shrimp.

COLUMBIA RIVER SALMON CATCH IS EXCELLENT

The Columbia River fall salmon fishery produced excellent commercial catches, reports the Oregon Fish Commission. Landings of coho approached 4.9 million pounds, the best since the mid-1920s. The bulk was taken below Bonneville. Only 184,000 pounds were landed in Indian commercial fishery above Bonneville; this reflects the general distribution of coho in Columbia River. Primary areas are in lower river. Few coho pass over Bonneville Dam and enter Indian fishery area.

Large % Hatchery Origin

Studies by the National Marine Fisheries Service (NMFS) and Oregon Fish Commission in 1969 show that 66% of coho taken below Bonneville and 48% of Indian catch above Bonneville Dam were of hatchery origin.

Chinook

Columbia River chinook landings were the best since 1951, almost 4.9 million pounds: nearly 4.2 million pounds in commercial fishery below Bonneville Dam, and over 700,000 pounds in Indian fishery above Bonneville. A preliminary report by NMFS states that between 1964 and 1968 35% of commercially caught fall chinook below Bonneville Dam and 49% of Indian catch above Bonneville were of hatchery origin.

Return of the native. Back to hatchery comes chinook salmon released 4 years before as fingerling. (USIA)

Large numbers of fall chinook salmon have returned to Fish Commission hatcheries in Columbia River system. Some chinook hatcheries in Oregon and Washington did not receive enough adult chinook to satisfy their egg-take requirements, but Big Creek hatchery's record return of 17,500 fall chinook yielded 33.4 million eggs. Eggs surplus to Big Creek hatchery's needs were supplied to other state and Federal hatcheries. The needs of all Columbia River hatcheries have been satisfied.

The Oregon Fish Commission says the hatchery program is making a "meaningful contribution to Nature's production of salmon in Oregon."

SALMON RETURN TO WILLAMETTE RIVER

Salmon have returned to Oregon's Willamette River, once too polluted for them. The 1970 spawning run of coho and fall chinook salmon is greater than all previous migrations, reports NMFS.

Credit goes to cooperative efforts by industry, state, and Federal agencies that improved water quality. Modern fishways are being installed at the Willamette Falls industrial center.

Salmon Counted

Using a technique developed by NMFS engineers, TV camera and video tapes, more than 35,000 coho and 7,500 "lunker" chinook salmon were counted at a new fishway.

Oregon is building 2 more new fishways: 84% of funds provided by Department of Commerce and administered by NMFS; 16% by private industry. (Information from Dr. Fred Cleaver.)

ALASKA ENJOYS GOOD FISHING

Alaska's 1970 fishery landings will be about a half-billion pounds worth $85-$95 million to fishermen. These preliminary estimates show a very good year, reports NMFS Juneau. The 1970 fishing season, like 1969's, appears to have made Alaska No. 1 state in value of landings, and either No. 2 or 3 in quantity.

SALMON

Preliminary catch estimates indicate that 1970 salmon fishery may equal or exceed 1966 bonanza of 333.3 million pounds. This would be largest since 1949, when 346.4 million pounds were landed.

Estimated landings for the 5 species of salmon were up over 1969: kings 4%; pink 15%; coho 18%; chum 105%; and sockeye 123%. Although salmon pack did not meet preseason predictions, still 1970 was one of best years.

The season's canned salmon pack of 3.68 million cases was second largest in 20 years; it fell just under 3.91 million cases in 1966. Four of the 5 species gained over 1969: sockeye, pink, chum, and coho salmon packs increased and totaled 1,794,000, 1,327,000, 472,000, and 56,000 standard cases. King salmon dropped to 27,000 cases from last season's 35,000. Sockeye and pink dominated season's pack: Bristol Bay provided most of sockeye pack (1,151,000 cases); Kodiak alone provided about one-third (465,000 cases) of pink pack.

HALIBUT

Preliminary estimates indicate 1970 Canada-U.S. halibut catch will reach 58 million pounds. It will parallel closely the 1969 catch, by regulatory area, which totaled 58.6 million pounds.

The Canadian and U.S. fleets landed estimated 26.7 million pounds of halibut in Alaska in 1970; this was increase of 26% from 1969. These landings were worth about $8.5 million to fishermen.

SHRIMP

An estimated record Alaskan catch of 71 million pounds worth $2.84 million to fishermen is anticipated in 1970. This is a 48% increase over 1969's record 47.8 million pounds.

One of most spectacular aspects of Alaska's 1970 industry is "explosive growth of the Kodiak shrimp fishery." It may produce estimated 60 million pounds of shrimp worth $2.4 million, exvessel, by season's end. This quantity alone more than doubles combined shrimp landings expected from rest of Alaska, Washington, Oregon, and California.

CRAB

Alaska crab landings--king, Dungeness, and snow--are expected to approach 75 million pounds in 1970, down about 5 million from 1969. It appears that 1968/1969 trend will be repeated this season: Estimated landings of king and Dungeness declining 7% and 20% from 1969, snow crab increasing 36%.

The estimated average 1970 price to fishermen for king crab was 27 cents per pound, down slightly from 1969. Dungeness crab was steady at 14 cents, and snow crab increased from 10 to 11 cents.

Alaskan Landings and Value to Fishermen 1969 and 1970 1/

Fishery	1969 Pounds	1969 Dollars	1970 Pounds	1970 Dollars
	(weight and value in millions)			
SALMON (Total)	211.87 2/	42.58	333.31	59.85
King	11.81	3.81	12.30	4.12
Sockeye	64.97	16.64	145.19	30.93
Coho	7.67	2.14	9.02	2.39
Pink	104.46	16.75	119.69	16.76
Chum	22.97	3.24	47.11	5.65
HALIBUT (Total)	21.20	7.14	26.71	8.55
State Landings--U.S. Fleet	16.64	5.58	19.11	6.11
State Landings--Canadian	4.56	1.57	7.60	2.43
SABLEFISH	0.47	0.06	0.49	0.07
SHELLFISH (Total)	130.30	22.44	148.04	20.81
King Crab	57.75	16.17	51.03	13.52
Dungeness Crab	11.53	1.65	9.17	1.28
Snow Crab	11.21	1.13	15.23	1.68
Shrimp	47.84	1.91	71.00	2.84
Scallops	1.89	1.55	1.45	1.42
Clams	0.09	0.03	0.16	0.04

1/Data furnished by Alaska Dept. Fish & Game and International Pacific Halibut Commission; 1969 figures subject to minor revisions, 1970 figures preliminary estimates.
2/Due to rounding, figures do not necessarily total.

ANCHOVY SPAWNED SUCCESSFULLY IN LA JOLLA LAB

For the first time, an important commercial open-sea fish has been spawned successfully under artificial conditions, reports Izadore Barrett, Acting Director, NMFS Fishery-Oceanography Center, La Jolla, Calif. Anchovy larvae produced from this artificial spawning fed and grew as normally in an aquarium as their counterparts in the sea. Additional batches have been produced in succeeding months and are continually being used for experimental purposes.

No member of the clupeid family--to which the anchovy, sardine, and herring belong--has ever been artificially induced to spawn in the laboratory. The results offer unique opportunities to study the response of marine fish eggs and larvae to such environmental factors as pesticides and heated effluents.

How It Was Done

Roderick Leong, NMFS fishery biologist who achieved this scientific first, has been working on inducing spawning in laboratory fish for more than a year under physiologist Dr. Reuben Lasker. During the experiments, Leong subjected adult anchovies kept in large aquaria to 4 hours of light and 20 hours of darkness for 4 months at about 15° C.

The fish were all from the same school. At intervals, they were injected with several types, dosages, and combinations of hormones. The combination that produced heavy spawning included commercial preparations of human chorionic gonadotropin (HCG) plus carp or salmon pituitary extract. In either case, it was not necessary to strip the fish to obtain sexual products--as usually is done with salmon and trout--because the fish released and fertilized the eggs themselves. The percentage of eggs hatching from these trials varied from under 19% in one trial to over 80% in others.

Insure 1 Male & 1 Female

During the experiments, the anchovies were fed squid and trout food, supplemented occasionally by ground anchovies and brine shrimp. Not all the injected fish spawned. Leong says it is not yet possible to synchronize gonad development completely, or to recognize superficially the sex or level of sexual maturity in anchovies. Therefore, 15 to 20 fish were injected in each experiment to insure that at least one male and one female would be mature enough to spawn.

Several weeks after the induced spawning, Leong observed that one group of anchovies in a large holding tank began to spawn spontaneously. This group had been held under same light and feeding conditions as injected fish. New eggs were found in special collectors for several consecutive days; the percentage of viable eggs ranged from 30 to 80%. Leong is experimenting with temperature change as a method to induce spontaneous spawning because this may be a way to obtain eggs without hormonal injections.

An Important Fishery

The northern anchovy is one mainstay of commercial fisheries off California. Fishermen were expected to take about 110,000 tons between September 1970 and May 1971.

COPEPOD WAX MAY BE A KEY TO HUMAN METABOLISM

Studies of naturally grown and laboratory-bred copepods may hold keys to important factors in human metabolism, Scripps Institution scientists believe. The copepods are tiny, shrimplike, marine organisms that weigh as little as 1/140,000th of an ounce or grow to an inch long in the deep ocean.

Copepod investigations at Scripps Institution of Oceanography, University of California, San Diego, have led to these conclusions:

Half the Earth's production during photosynthesis is converted for a time to wax by the copepod, the ocean's most numerous and diverse marine animal.

The copepod population off California alone is estimated to have 800,000 tons of liquid wax, a much larger amount than the oil of the 'Torrey Canyon' or Santa Barbara spills.

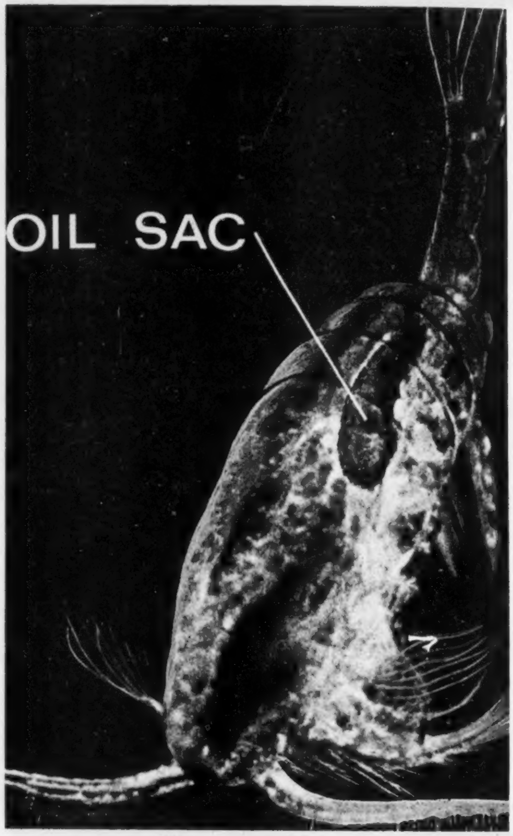
The copepod is the first animal in marine food chain. It is the predominant animal that can "graze" on microscopic algae (diatoms and dinoflagellates).

'Who eats whom' in the ocean may be determined by the nature of the wax and hydrocarbon compounds in the predator and the prey.

Scripps Study

Scripps has duplicated the complete life-cycle of the copepod in the laboratory. A team has been studying the occurrence of wax in copepods for more than a year. Copepods are called "insects of the sea."

The scientists report that wax appears to be a major medium for transferring and storing energy in marine organisms. The copepod lives upon microscopic plants called phyto-



Enlarged photo of $\frac{1}{8}$th-inch marine copepod 'Calanus', "insect of the sea." Oil sac is toward rear of its tiny body. Wax is used for energy storage and food supply during periods of starvation and hibernation in long winters. Wax is made from oils of algae that it eats (darker area below sac).

plankton and converts their fat into polyunsaturated liquid wax. It stores this in its oil sac.

These waxes are unique because they are metabolized readily by the copepod, which uses them as a reserve supply of energy. These waxes differ from plant leaf waxes, bees' wax, and animal waxes, which are not metabolized easily.

Dr. A. A. Benson, director of Scripps' Physiological Research laboratory, said: "Further along in the marine food chain the copepods are eaten by predators--sardines, anchovies, herring, and young salmon--who, in turn, convert the waxes back into common fats so widely used for human food. These fishes are the world's specialists in metabolism of waxes."

This wax metabolism helps control the copepods' ability to survive their hostile environment, Dr. Benson added, and it may serve a similar purpose in higher marine animals.

Waxes As Possible Keys

Waxes are compounds of ordinary fatty acids combined with fatty alcohol, the scientists say. They are studying the conversion of this fatty alcohol back to the fatty acids of fishes.

Dr. Benson notes: "Additional knowledge about this apparently complex chemical process may give us the key to an important factor in human metabolism. The intermediate compound which must participate in this conversion occurs as a major component of human heart muscle and brain, but its existence has never been explained. We hope that nature's specialists in this process, the copepods and anchovies, will give us clues to answers, with the possible end result that we might have a better understanding of the energy production of heart muscle and nerve activity in the brain."

The scientists estimated 800,000 tons of liquid wax were contained in the copepod population off California by actually counting the quantity of the organisms in a cubic meter of seawater.

The major copepod of the oceans, Calanus, has been grown artificially by Dr. Michael M. Mullin of Scripps, and by Dr. Gustav A. Paffenhofer, a visiting German zoologist, on pure cultures of diatoms, green single-cell algae.

They grew the copepods throughout their life cycle by almost-hourly feedings.

"The well-fed Calanus contains 70 percent of its dry weight as wax, which is 40 percent of its total fat," reported Dr. Judd C. Nevenzel.

"We have analyzed the wax and fat content of single copepods weighing only 1/2,500th of a gram, or 1/140,000th of an ounce, added Richard Lee, a graduate student. "Deep-sea copepods are larger, nearly an inch long, and are 60 percent wax. Arctic copepods have been found that contain 70 percent lipid, which is made up of 91 percent wax."

WARM SPOT IN N. PACIFIC OCEAN CAUSING EASTERN U.S. TO GROW COLDER

Eastern U.S. and other parts of the world have been experiencing cooling trends in recent years. Explanations include: air pollution is blotting out part of the sunlight; increased volcanic dust may be doing this; the world may be experiencing a cyclical variation in the sun's energy output.

NOAA Expert Suggests Cause

A fourth possibility has been suggested by Jerome Namias, chief, Extended Forecast Division of National Weather Service, and research scientist for Scripps Institution of Oceanography. He points to oceans as a cause. Observed changes in ocean temperature seem linked to large-scale displacements of air currents around the globe, he notes.

Meteorologists generally accept that the oceans are generators of world weather. This is one reason why the two were brought together in 1970 in a new Commerce Department agency--the National Oceanic and Atmospheric Administration (NOAA).

The oceans cover about 70% of earth's surface. They change temperature much more slowly than air above, and so act as "a sort of governor" on global climate.

Namias Argument

Meteorologist Namias argues that air-sea relationship is so basic that "scientists may be overlooking the most important factor by neglecting this interaction" when trying to explain cooling trends. He believes it "quite possible" that warm surface water in North Pacific is responsible for colder winter in eastern U.S.

How could warm ocean water produce cold winds thousands of miles away? Namias says that you need to visualize the high-level river of air that undulates from west to east around Northern Hemisphere. This planetary flow, whose core is the jet stream, is a permanent feature of the atmosphere, although its distance from Equator and sinuous shape are changing constantly.

Winter Jet Stream Shifted

During the 1960s, says Namias, a persistent shift took place in winter jet stream. A pattern akin to that in accompanying map occurred more often than previously. Cold air from the north swept down repeatedly over eastern two-thirds of U.S. The result was that in the east "winter temperatures averaged 1 to 4 degrees Fahrenheit below the 1931-60 mean," he says, while "west of the continental divide, temperatures averaged above normal."

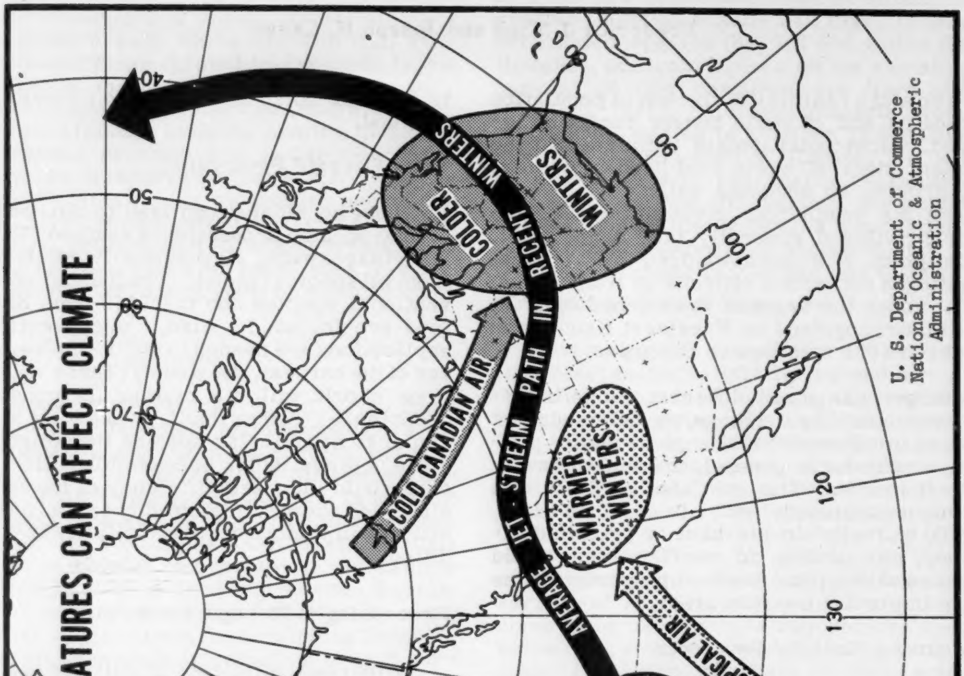
During practically all 10 winters, temperatures averaged below normal in eastern half of U.S.

The demonstrable link between global wind flow and this particular cooling trend makes it "unlikely" that air pollution and volcanic activity have much to do with it, Namias thinks.

More Probable Cause

Much more probable is an association with an ocean-temperature change in which "the sea surface over much of the North Pacific was abnormally warm." This has strengthened storm systems there. Ultimately, this generated more frequent wind flows than usual from Canadian Arctic into eastern U.S.

Even though we may not know what causes such oceanic warming, Namias notes, it is important to recognize significant effect it can have on climate. "It may be shortsighted to invoke extra-terrestrial or manmade activity to explain these fluctuations."


HOW OCEAN TEMPERATURES CAN AFFECT CLIMATE
COLD CANADIAN AIR
COLDER WINTERS
AVERAGE JET STREAM PATH IN RECENT WINTERS
WARMER WINTERS
WARM WATER
WARM WATER ENERGIZES STORM SYSTEMS, DEFLECTING JET STREAM NORTHWARD
WARM TROPICAL AIR
U. S. Department of Commerce
National Oceanic & Atmospheric
Administration

HOW TO USE NEARLY ALL THE OCEAN'S FOOD

Frederick J. King and Joseph H. Carver

The stark realities of the world population explosion and of world hunger cannot be ignored. Most nutritionists estimate that the present state of world food production does not provide an adequate daily diet for two-thirds the population. Even in the U.S., the underprivileged generally lack a good diet. This point was acknowledged by a recent meeting of concerned citizens in Washington, D.C., under the aegis of President Nixon. It was also recognized by President Kennedy in a March 1961 message to Congress.

Hunger can mean different things to different people. By and large, the nutrient most lacking in deficient diets is good-quality protein; seafoods, in general, are known as excellent sources. They are also good sources of polyunsaturated lipid. In abundant diets, which typically do not have a protein deficiency, the ability to replace other lipid sources with typical seafood polyunsaturates is an important consideration.

Resources Must Be Developed

Although some claim that a specific approach will solve overt or hidden hunger, most experts believe several conventional and unconventional resources will have to be expanded or developed to meet our present and future desires or choices for good-quality foods (Mateles and Tannenbaum 1968). Seafood is an example of a conventional resource, yet the ocean's capacity to produce food has not been achieved. For example, under present conditions and fishing techniques, there is a significant waste of potentially edible animal protein. Most vessels look for particular species; other species that come up with the catch are thrown overboard. This wastes time, effort, and potentially nutritious food. Even with species saved, more than half the body may be discarded at sea or ashore. It has not been economically feasible to harvest other species or to process them for food.

Total Oceanic Production

These considerations lead to the concept of total oceanic production of seafood (TOPS). It envisages using all potentially edible parts from all species landed. Traditional or conventional species and market forms of seafood are included. Also, "unconventional" applications are needed to utilize the remainder of the harvest. Obviously, these applications should tailor a product for consumer acceptance--rather than try to educate a consumer to a particular species that might become less available. Successful applications also would increase efficiency of harvesting effort and thereby maintain ocean's food resources in a more economically healthy condition.

Processing & Storage Techniques

To increase efficiency of utilizing our marine resources for food, we need to develop appropriate processing and storage techniques afloat and ashore. Such a development has occurred in Japan during last 20 years (Tanikawa 1963). To meet increasing domestic demands for good-quality protein foods, a family of machines and appropriate technology were developed. The machines remove edible flesh from bones and skin and convert the minced flesh into a "universal" material that can be preserved by freezing. It is called "surimi." It can be considered basic ingredient in manufacturing food items, such as fish cake or paste ("kamaboko"), several kinds of sausages ("chikuwa," "tokuyo," and ham sausage). Potentially, surimi can be used in other products, such as soups, fish puffs (different fish flavors), meat-flavored chunks, frankfurters, dehydrated cubes or

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flakes, controlled size portions, and snack-type items.

At present, such applications in U.S. seafood industry are limited to Japanese types of products made from surimi. However, another U.S. food industry dealing with proteinaceous flesh as food, the poultry industry, has learned recently how to use meat/bone separators to recover edible meat from processing "wastes" such as poultry necks and backs. This comminuted (pulverized) poultry meat (or "poultry surimi") is being added to soups, various types of meat sausages, or used as a binder for canned or frozen poultry meat.

Surimi-Type Ingredient

These considerations are similar to those developed by Miyauchi and Steinberg (1970). Although they used different species and machines, a more fundamental difference between their report and this one is present emphasis on a surimi-type ingredient rather than end-use food items. Obviously, various foods are helpful to evaluate or discuss the applicability of a food ingredient. Equally helpful, and perhaps more important in commercial applications, is developing technological and economic information on this surimi food ingredient.

The successful use of Japanese machines for seafood production, and the use of similar machines in the U.S., led us to explore potential applications of such machines in domestic seafood industry. This work involved three considerations: 1) sources of raw material, 2) technological and economic considerations in processing this material into surimi food ingredient, and 3) potential applications of this surimi.

Sources of Raw Material for Machine Separator

The ocean's fauna include many species. For this work, the sources of raw materials may be grouped into two broad categories: fish frames (waste material obtained from filleting lines), and underutilized fish (species caught incidentally to other species, or not presently caught). Characteristically, the anatomy or size of these underused species is not amenable to present filleting methods. Thus, this source could be used as headed and gutted (H&G) fish rather than fish frames.

The potential volume and value of these two sources are important considerations. The greater potential volume will come from underutilized species (headed and gutted fish). However, accurate figures on the sustainable harvest of this resource are hard to find (Bardach 1968). Although potential volume of filleting wastes is smaller, it depends on landings of fish used for filleting. So, it can be estimated with reasonable certainty. In New England alone, for example, the potential volume of machine-separated meat from filleting wastes has been estimated at 56.9 million pounds annually (Carver and King 1970).

Raw-Material Cost Important

Obviously, the cost of raw material is as important as its availability in considering its potential use. In developing cost estimates for these two categories, we have attempted to recognize all cost increments up to point where the material enters a meat/bone separator. For fish frames, an estimated value of 6 cents per pound appears reasonable (Table 1). For underutilized species (H&G), about 9 cents (Table 2), even though there is much speculation about estimate because of variety of species involved. For example, some underused species may require special harvesting methods, heading and gutting machinery, or they may have an unattractively low yield of machine-separable ground meat.

Marine Invertebrates Included

Theoretically, such marine invertebrates as crustaceans, molluscs, and other groups are considered as sources. Although some of these species now are fully utilized, edible meat can be recovered from processing wastes. Typically, these wastes come from such cooked animals as crabs, lobsters, or shrimp. Ground meat has been recovered from such wastes by machine separators (Carver and King 1970; Miyauchi and Steinberg 1970). It contains shell fragments and has lost some important functional properties of raw meat. However, it can be processed into such food products as spreads, pastes, or bisques. Recovery of raw meat from animals containing a brittle exoskeleton has been done with an ordinary chopper followed by filtering. However, a meat/bone separator was unsuccessful in removing raw meat from intact rock crab legs or cores. For such reasons, it is advisable to consider marine invertebrates separately from finfish sources.

Table 1 - Estimated cost of raw material source for machine-separated ground meat when obtained from fish frames

Description of processing or handling step	Estimated cost in cents per pound	
	Cost added by step indicated	Total cost at step indicated
1. Price of filleting wastes--contain heads but no viscera and no skins from filleting operation	1	1
2. Handling, temporary storage by icing, and transport to using facility	1	2
3. Beheading (to remove eyes for aesthetic reasons)		
a. Labor 4 men @ \$2.50 per hour each @ 250 lbs. per hour each.	1	3
b. Yield of 48% usable material remaining[1]	$\frac{3}{.48}$	6.25[2]

1/Experimentally determined value using cod frames.
2/If heads can be sold for gurry at one cent per pound, this figure will be reduced by 1 ¢ (52%) or 0.52 cents.

Table 2 - Estimated cost of raw material source for machine separated ground meat when obtained from underutilized fish

Description of processing or handling step	Estimated cost in cents per pound	
	Cost added by step indicated	Total cost at step indicated
1. Ex-vessel price for harvest[1]	3	3
2. Heading and gutting, Theoretical machine with capacity of 1000 lbs. per hour and two men at \$2.50 per hour each to operate it. Cost of machine and its operation.	2	5
3. Yield of suitable raw material for separation of flesh after step 2 is 55 percent.[2]	$\frac{5}{.55}$	9.1[3]

1/This figure is based on special trips for this material. Ex-vessel prices for material caught incidental to efforts for species with other end uses may be lower, but this source of supply may be smaller and more erratic.
2/Assumed average value for all species. The yield of headed and gutted ocean perch was determined on 107 individuals in one lot with an average yield of 55.4% ± 2.1%. The yield of headed and gutted red hake was determined on 10 representative individuals in a 75 pound lot with an average yield of 62.1% ±7.6%. Yield data for nine other species are presented in Miyauchi and Steinberg (1970).
3/If heads and viscera can be sold for by-products at one cent per pound, this figure can be reduced by 1 cent (45%) or 0.45 cents.

Machines For Experimental Work

Most experimental work reported here was based on using the Bibun[1] family of machines. The basic unit in this family is a meat/bone separator (Figure 1). This machine removes flesh from suitable materials by squeezing and tearing actions. It contains a wide flexible belt that moves against the outside of a rotating, perforated metal drum. The belt and drum move at different speeds in same direction. In operation, flesh is separated from skin and bones by a shearing action due to difference in speeds between drum and belt. Since flesh is softer and is less cohesive than skins or bones, the pressure developed between drum and belt drives it through perforations of drum. Skin and bones remain behind on belt.

The Strainer

The strainer (Figure 2) is used to "finish" comminuted (pulverized) flesh obtained from a separator. Material fed into this machine is moved by an auger against a stationary perforated metal cylinder (Figure 3). These perforations are only about one millimeter in diameter, so any small bones or pieces of

1/The use of trade names facilitates description of experimental procedures; no endorsement is implied. At least two other Japanese firms, Yanigiya Machinery Works, Ltd., and Ikeuchi Iron Works, Ltd., one Swedish firm, A. B. Iwema, and at least two U.S. firms, Beehive Machinery, Inc. and Stephen Paoli Manufacturing Co., manufacture meat/bone separators. The Bibun Machine Construction Co., Ltd. is the only firm we know that manufactures a strainer as well as a separator.

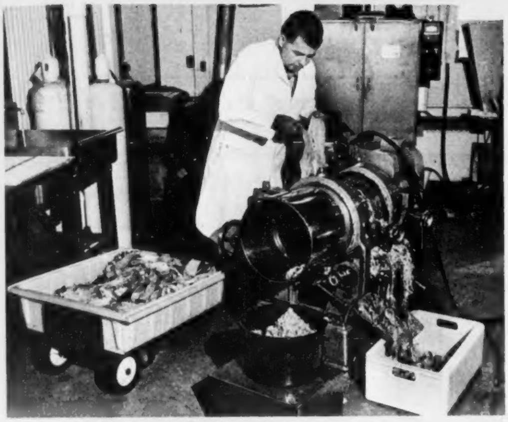

Fig. 1 - Processing filleting leftovers in Bibun meat/bone separator.

Fig. 3 - Close-up view of a Bibun strainer.

Fig. 2 - Processing machine-separated flesh through a Bibun strainer.

skin present are separated from flesh, which is homogenized by passing through these holes. The auger is kept cold to prevent heat damage to fish flesh by circulating cold water inside it.

Although this strainer was designed for use with material containing raw flesh and bones, we have tried using it to remove shell fragments from cooked blue crab, lobster, and shrimp material. The shell fragments and the lower moisture content of the flesh in these materials created some difficulties in processing them through this machine. However, by redesigning auger and by adjusting throughput rate, it appears these difficulties can be overcome. After passing through small holes of strainer, these shellfish pastes or bisques did not have organoleptically detectable (involving sense organs) shell fragments.

Considerations In Using Machines

An estimate of the cost of using this family of machines is given here. The figures used are intended merely to visualize the process. A commercial processor should check our assumptions against his particular situation. In this concept, one separator and two strainers are assumed at an initial total cost of $20,000 and depreciated over 5 years. (Leasing instead of buying machines might reduce cost.) To this cost, add costs for running machines, such as energy utilization, replacement parts, and maintenance.

To develop this concept, we also assumed these machines should handle up to 4,000

Table 3 -- Yield of flesh obtained from several species of headed and gutted fish using a meat-bone separator. 1/

Source of material	Scientific name of species	Yield of flesh obtained	Reference source
H & G Northern anchovy,	Engraulis mordax	92.6	Calculated from table 1 of
H & G Spiny dogfish	Squalus acanthias	77.0	Miyauchi and Steinberg (1970)
H & G English sole	Parophrys vetulus	84.1	"
H & G Pacific hake (Puget Sound)	Merluccius productus	88.4	"
H & G Pacific herring	Clupea harengus pallasi	69.5	"
H & G Lingcod	Ophiodon elongatus	77.0	"
H & G Silvergray rockfish	Sebastodes brevispinis	80.6	"
H & G Starry flounder	Platichlhys stellatus	79.4	"
H & G Pacific cod	Gadus macrocephalus	69.4	"
H & G Croaker	Micropogon undulatus	70	Miyauchi and Steinberg(1970)
H & G Croaker	"	75	"
H & G Porgy	Calamus sp.	65	"
H & G Ocean perch	Sebastes marinus	69.4	
H & G Ocean perch	"	62.4	
H & G Whiting	Merluccius bilinearis	86	
H & G Mackerel	Scomber scombrus	65.0	
H & G Red hake	Urophycis chuss	69.8	
H & G red hake	"	83	
H & G Israeli carp	Cyprinus sp.	72.4	

1/ Yield data based on material entering and leaving the separator. It is not based on the whole animal since it does not include the heads and viscera.

Table 4. --Yield of flesh obtained from fish frames (filleting wastes) using a meat-bone separator [1/]

Source of material	Scientific name of species	Yield of flesh obtained
Cod frames	Gadus morhua	59.0
Cod frames	"	66
Pollock frames (large)	Pollachius virens	60
Pollock frames (small)	"	72.2
Haddock frames	Melanogrammus aeglefinus	56
Wolffish frames	Anarhichas lupus	66
Cusk frames	Brosme brosme	70
Whiting frames (from only large fish)	Merluccius bilinearis	55
Ocean perch frames	Sebastes marinus	38.6
Ocean perch frames	"	31.2
Yellowtail flounder frames	Limanda ferruginea	47
Rockfish frames	Sebastodes sp.	51.0 [2/]
Trout frames	Salmo gairdneri	68 [2/]

1/ Yield data based on material entering and leaving the separator. It is not based on the whole animal since it does not include heads, viscera, or fillets.

2/ Calculated from Figure 2 of Miyauchi and Steinberg (1970)

Table 5. -- Comparison of fillet yield with yield of edible flesh obtained from filleting leftovers.

Source of material as landed 1/	Yield of fillets 2/	Yield of machine-separated flesh obtained from filleting waste 3/	Total estimated yield of edible flesh 4/
Cod, eviscerated	37	19	56
Cod, eviscerated	37	12	49
Wolffish, eviscerated	34	20	54
Cusk, eviscerated	36	22	58
Whiting, eviscerated (large fish only)	48	17	65
Pollock, eviscerated	40	18	58
Pollock, eviscerated	38 5/	20	58
Haddock, eviscerated	40	17	57
Yellowtail flounder, whole	34	16	50
Ocean perch, whole (min. amount of candling)	30	19	49
Ocean perch, whole (avg. amount of candling)	25	20	45

1/ Scientific names of species are given in Tables 3 and 4

2/ Estimated values based on current commercial filleting yields. Values expressed as lbs. of fillets per 100 lbs. of fish as presently landed (whole or eviscerated). These values are for "skin-off" fillets. For "skin-on" fillets, these values would be higher by about 3 lbs. per 100 lbs. of fillets.

3/ Values expressed as lbs. of edible flesh per 100 lbs. of fish as presently landed (whole or eviscerated). These yield figures are lower than those in Tables 3 and 4 because fillets, heads(eviscerated fish) or heads and viscera(whole fish) were not fed into a separator.

4/ Sum of values for fillet yield and machine-separated flesh yield given in preceeding columns. Expressed in lbs. of edible flesh per 100 lbs. of fish as presently landed (whole or eviscerated).

5/ Measured yield for this lot of fish which were smaller than those normally used in the trade.

Table 6 -- Recent prices for some present-day frozen fish products. All of these prices are F.O.B. Boston or Gloucester, Massachusetts. They do not include charges for storage over one to three months.

Description	Marketing Unit	Price per pound
Frozen blocks 1/		
Cod (regular)	16 1/2 lbs.	$0.30
Cod (minced)	13 1/2 or 16 1/2 lbs.	0.15
Haddock (regular)	16 1/2 lbs.	0.38
Pollock (regular)	16 1/2 lbs.	0.21
Flounder (regular)	16 1/2 lbs.	0.42
Greenland Turbot (regular)	16 1/2 lbs.	0.32
Ocean Perch (regular)	16 1/2 lbs.	0.21
Frozen fillets, 10 lb. package of cello wrapped fillets.	Five 10-pound packages per master carton.	
Cod	"	$0.33
Haddock	"	0.55
Pollock	"	0.28
Flounder	"	0.58
Greenland Turbot	"	0.40
Ocean Perch	"	0.37
Whiting	"	0.31
Ocean Catfish	"	0.38
Hake	"	0.26

1/ Block is a trade designation for fillets (regular block) or pieces from fillets (minced block) which are packaged into a box and then frozen en masse.

Scientific names for these species, except Greenland turbot (Reinhardtius hippoglossoides), are contained in Tables 3 or 4.

pounds of input material per hour during 7,000 hours of operation in this depreciation period. Based on these somewhat arbitrary assumptions, a machine cost of less than 0.1 cent per pound of input material was obtained. To this add relevant labor costs. (Overhead and other indirect costs will be totaled with projected costs of products obtained.) Since all the machines are assumed to have automatic feed and discharge systems, the assumed labor costs were based on two semiskilled operator-laborers at $2.50 per hour each. Adding this labor cost of 0.125 cent per pound of input material to machine cost of less than 0.1 cent per pound, you get a total cost of about 0.2 cent per pound.

The costs of using these machines must be absorbed by yield of final product, so several laboratory tests were made here and elsewhere to estimate yields from various sources. The yields presented here were based on using only the separator. In other experiments, the ground flesh output from separator was fed into strainer. It was found that the strainer could be operated in a variety of ways to influence properties of comminuted flesh. However, there was relatively little effect on yield of material when over 100 pounds of ground flesh were processed through strainer.

Data show large variation among fish species. Much of this variation may be due to seasonal variability in feeding habits, as well as species differences in anatomical structure and size. This variability appears reduced when you recalculate available results from a basis of whole fish (as purchased) to a basis of headed and gutted fish as fed into a separator (Table 3). In absence of enough data on size or plumpness of fish used to yield of machine-separated flesh, these figures should be considered estimates.

With frames (filleting wastes), available yield data appear more consistent (Table 4). It appears that a yield value can be estimated with reasonable accuracy for a given anatomical structure. For a species, the principal batch-to-batch variations in yield of machine-separated flesh appear related to individual skill of hand-labor in cutting out fillets before we obtained the frames. If one combines yield of machine-separated flesh from these frames with estimate of filleting yield, the total amount of edible flesh can be estimated (Table 5).

Using Ground Edible Flesh From Machine Separation

In considering applications for ground edible flesh or "surimi" as an ingredient in food products, economic projections should be made to estimate whether addition of this food ingredient is justifiable. One such projection follows.

By using reasonable assumptions, arbitrary prices for machine-separated flesh can be derived. We have estimated a price of 6.25 cents per pound for fish frames delivered to the family of machine separators (Table 1), and a cost of 0.2 cent per pound using these machines (previous section). Assuming average yield of 60% for ground flesh (Table 4), value of meat at this stage is $\frac{6.45}{.60}$ or 10.8 cents per pound. (If skin and bones can be sold for meal production at one cent per pound, this figure can be reduced by 0.4 cent per pound.) Although this flesh can be used immediately, we assume it will be packaged and frozen-stored for later use in a food product. Packaging costs for labor and materials (10-pound waxed cartons in a 5-unit master case) are estimated at 2 cents per pound. Then, by adding freezing cost of one cent per pound, we obtain total value of 13.8 cents per pound for this meat. Storage costs are estimated at one cent per pound for first month, and 0.5 cent for each succeeding month. The duration of this storage period, transportation costs to final processor or user, profit, overhead, and insurance costs will vary considerably. If we assume these costs will average 20% of frozen meat's value, a final value of about 17 cents per pound is derived.

By using similar assumptions and calculations, a final value can be derived for frozen-stored meat obtained from underutilized (headed and gutted) fish. In this case, the raw material cost will be higher, say 9.1 cents per pound (Table 2), if harvesting costs have to be borne by this material. However, the yield of machine-separated meat should be higher, and an average yield of 78% is reasonable (Table 3). Using these figures, a final value of about 18 cents per pound is derived for frozen-stored meat delivered to final processor or user.

The estimated values of 17 or 18 cents per pound for this frozen-stored fish meat product ("surimi") are favorable when compared

with recent prices for frozen-stored fish fillets (Table 6). The values are presumed at least comparable with poultry, beef, or pork meat.

On the basis of these value projections, it appears that several food applications are economically justifiable. Some potential applications already have been considered, although economic projections have not always been included.

Fish cakes and canned fish products have been proposed (J.M. Mendelsohn, unpublished work cited in Carver and King 1970). It has been used as a binder or matrix in fish loaf or jellied roll-type products (Carver and King 1970; Learson, et al., 1969). It has been proposed as basis for sandwich or hors d'oeuvres types of spreads (Miyauchi and Steinberg 1970). It can be used to make a beefless frankfurt or similar products (Carver and King 1970). In this application, more recent studies have demonstrated that by processing machine-separated flesh through the strainer, complete elimination of all bone particles in the product is assured and its textural quality improved.

Another potential application occurs in institutional or commercial mass feeding. These enterprises continually seek ways to maintain or upgrade nutritional quality of their menus, while holding line on ingredient costs. Several of their popular recipes, hamburgers, sloppy joes, meat loaf, American chop suey, stuffed pepper, chili con carne, or spaghetti with meat sauce, depend on ground beef for animal protein ingredient. Results of preliminary tests suggest it is possible to continue freshly prepared machine-separated fish flesh with ground beef ("hamburger") in such recipes. Currently, we are determining the frozen storage life of this minced fish flesh by combining it with ground beef in these recipes.

CONCLUSIONS

On the basis of preliminary evidence, it appears that meat/bone separators and ancillary machines could be employed profitably by U.S. seafood industry. Further exploratory work is suggested to determine storage characteristics of the ground flesh ingredient ("surimi") and to develop food applications for it.

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HYDROGEN SULFIDE KILLS

Richard W. Hamilton

The following is a fictionalized account of a tragic incident that we must be prepared to read as truth at some time in the future. Circumstances can and have caused it to happen. That it has not happened more frequently is plain luck.

"Dateline: Anywhere, World; Anytime, 20th Century.

"With her engines muttering, the purse seiner crawled alongside and bumped into the dock with a dull thud. Lines snaked out, slack was taken in, and tied securely. The captain, the plant manager, even the spotter pilot, crowded expectantly onto the deck to watch the unloading of the first catch in over a week. Since the plant had been operating spasmodically all summer long, the arrival of a boat with fish covering the bottom of her hold was an event with more than usual import.

"As the hose man stepped gingerly into the hold, the pumps were turned on and valves opened. In preparation for the jolt that always comes when water under pressure jets out of the black orifice at the end of a high pressure hose, the man spread his feet and braced himself. He felt the hose quiver and he involuntarily tensed himself. The water came--only it was not water. It was dark and thick. Instantaneous, unannounced, DEATH spewed out.

"Rescue attempts began immediately. A man instinctively lunged into the hold. He did not even reach his stricken comrade before he too was felled. Hooks were tried, more lunges, more limp bodies. Seven men lay unmoving in and around that ill-fated hold. Not until local authorities with gas masks arrived were rescue attempts successful. Miraculously, two men recovered; five died.

"What hellish substance caused this nightmare? Hydrogen sulfide gas." End of transmission.

THE GAS

The gas (H_2S) is composed of only two elements: hydrogen and sulfur. It is known chemically as hydrosulfuric acid. It is written symbolically as H_2S--indicating a composition of two atoms of hydrogen and one atom of sulfur. If air is assigned a density of one, then H_2S has a density of 1.186. This means that it is heavier than air and will remain in the bottom of a fish hold or storage tank.

The gas is easily detected by the human nose in extremely low concentrations. The odor--rotten eggs--may be recognized in concentrations as low as two parts per billion. One of the most dangerous and deceptive characteristics of H_2S is that it quickly fatigues the sense of smell, thereby stripping a person of his only source of warning. Concentrations as low as 10 ppm are toxic, even though 600 ppm may be survived for as long as 30 minutes. At high concentrations, collapse, coma, and death from respiratory failure may come within a few seconds after one or two breaths. Low concentrations produce irritation of the eyes, nose, mouth, and throat. Headache, dizziness, nausea, lassitude may also appear.

Another dangerous characteristic of the gas is that it has a flash point of 500° F. Thus, if H_2S is present in high-enough concentrations and comes in contact with a surface heated to this degree, an explosion and fire will result. The gas is potentially explosive in concentrations from 4.3 percent to 46 percent.

How Gas Is Produced

Hydrogen sulfide is produced in the laboratory by the reaction between calcium

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sulfide and magnesium chloride. Commercially, it is manufactured by reacting dilute sulfuric acid with iron sulfide, by emiting hydrogen vapor with vaporous sulfur, or by heating paraffin and sulfur. There are many important uses for H_2S--in manufacturing other chemicals, in metallurgy, and in research laboratories.

When produced on purpose and contained, hydrogen sulfide aids mankind. When produced accidentally and not contained, it may be one of the very deadly poisons. In this latter case, hydrogen sulfide is produced biologically--primarily by bacteria. Several types of bacteria produce H_2S, but we are concerned here with only those species that can produce toxic quantities of H_2S in the fishing industry.

What conditions are necessary for the microbial production of H_2S?

1. A temperature high enough for bacteria to grow.

2. Absence of oxygen.

3. A source of organic sulfur.

When these conditions coexist, even for a few hours, biologically produced H_2S may reach toxic concentrations.

An examination of any fishery installation will reveal several areas where these conditions might exist, either intermittently or permanently. When a suspension of protein material such as fish flesh and slime is allowed to stand untreated, even for a short while, a series of events occur that will lead to the evolution of H_2S.

Initially, there is a rapid microbial growth with a twofold result: (1) an anaerobic (no oxygen) environment is created, and (2) the temperature is raised. As this microbial degradation or fermentation proceeds, even more heat is evolved, and conditions favorable for the growth of H_2S-producing bacteria come into existence. After the favorable temperatures are reached, these bacteria attack the sulfur-containing amino acids--cystine, its reduced form, cysteine, and methionine. All of these amino acids occur in fish flesh. The release of large quantities of the morbid gas--hydrogen sulfide--follows. An external source of heat, from processing or daytime temperatures, may allow the fermentation stage to be shortened or preempted with the almost-immediate evolution of H_2S.

Thermophilic (heat loving), anaerobic, sporeforming bacteria, such as Clostridium nigrificans, are everywhere; when H_2S is detected, they are usually the culprits. Other bacteria in the same genus probably better known to the public are Clostridium tetani and C. botulinum, the causes of "lockjaw" and botulism poisoning, respectively.

A Lesson In Deduction

Armed with this knowledge, we are now prepared to objectively assess conditions at the site of the tragic accident. Analyzed samples of the contents of pipes and lines leading to and from the pumps revealed the presence of a supersaturated solution of H_2S along with a tremendous amount of organic material.

Let us list all the facts we know:

1. The plant has not operated for over a week.

2. The time is mid-August with daytime ambient temperatures in sunlight as high as 105-110° F.

3. Analysis of pipe contents revealed large amounts of organic material as well as H_2S. Since this factory uses fish as a raw material, we can assume the organic substance was of animal origin; also, that it contained the sulfur-containing amino acids cystine, cysteine, and methionine.

4. The sealed pipelines afforded an anaerobic environment.

5. Whatever killed the crewmen was not present in the hold when the hose man first entered it--because neither he nor the men around the hold complained of unusual conditions.

6. No outward danger signs were present to signal impending disaster.

The inescapable conclusion: The victims succumbed to hydrogen sulfide gas--because:

1. An anaerobic environment existed in the closed pipelines.

2. The summertime temperatures were high enough to enhance, or at least allow, the growth of H_2S-producing bacteria.

3. Organic sulfur was present in the form of fish proteins.

4. Hydrogen sulfide producing bacteria are found anywhere and their presence in the closed pipeline is almost a certainty.

5. With a shut-down of over a week, there was more than enough time for a lethal concentration of H_2S to be evolved.

How To Prevent This

The sorrowful sequence of events just described need never be repeated. Even though the potential circumstances for H_2S intoxication exist in many segments of the fishing industry throughout the world, the prevention of this type of accident is extremely easy:

1. All water lines leading to and from pumps should be flushed before and after each use.

2. Stickwater, bailing water, and other such solutions should never be stored untreated. They should be processed as quickly as possible--either acidified or otherwise treated so that bacterial growth will be prevented or retarded.

3. All storage tanks should be equipped with forced air ventilation.

4. With the many relatively inexpensive H_2S-testing kits now commercially available, routine testing of potential danger areas should be a must.

FPC'S QUALITY VIRTUALLY THE SAME AS ITS RAW MATERIAL'S QUALITY

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Several years ago, the National Marine Fisheries Service (then the Bureau of Commercial Fisheries) began a program designed to produce a satisfactory protein concentrate from whole fish. The purpose was to help alleviate the protein malnutrition that affects much of the world's population and to provide an economic stimulus to the U. S. fishing industry. A high-quality protein is needed to supplement the vegetable proteins, which are the world's principal source of this important nutrient.

The use of fish for this purpose is ideal because the seas abound in unutilized species. The concept of FPC is not new. Knobl (1967) reviewed descriptions of several processing methods. Chemical methods have used isopropyl alcohol as a solvent (Guttman and Vandenheuvel, 1957; Dambergs, 1959; Power, 1964; and National Marine Fisheries Service, 1966).

Isopropyl alcohol has been shown highly efficient in removing lipid and water from raw material. A product containing high-quality protein can be obtained by isopropyl alcohol extraction of various species of fish.

Thus far, few investigations have compared the chemical composition and nutritive quality of the raw material with that of the FPC processed from it. So we have not known whether the solvent extraction and later processing produces any significant change in quality from that of raw material.

This report presents results of a comparison of FPC's chemical composition and nutritive quality with the same properties of the raw fish used as starting material.

The FPC data were obtained in early stages of National Marine Fisheries Service program, when a batch cross-current method of extraction was used. Although the present method is a straightforward stagewise countercurrent method, we have found no difference between the two methods of extraction with respect to chemical composition and nutritive value. The principal difference is in the efficiency and economy of solvent usage. For this report, the FPC data are representative of FPCs prepared by isopropyl alcohol extraction of red hake regardless of extraction method.

WHAT WE FOUND

The chemical and nutritive properties of freeze-dried whole fish and FPC (fish protein concentrate) made from red hake (Urophycis chuss) were studied. Samples of whole fish were collected during July, October, and November 1964, and January 1965. The products were analyzed for proximate composition, amino acid concentration, and protein efficiency ratio (PER).

The samples of freeze-dried whole fish showed only slight changes in chemical composition, notably in lipid content, which ranged from 9.8% to 14.2% (dry weight). The PERs ranged from equal to casein to PERs significantly better than casein (July, October, and January).

The FPC samples prepared from same catches of fish showed only slight differences in concentration of crude protein; this ranged from 86.5% to 89.9%. The PERs of these samples also ranged from equal to casein (October and November) to PERs significantly better than casein (July and January).

With the exception of the October period, FPC's nutritive quality did not differ significantly from raw material's.

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EXPERIMENTAL PROCEDURES

Raw Material

The whole red hake was chosen as raw material for this study because it is an underutilized species and readily available to this laboratory. The fish were caught near Block Island, off Rhode Island. The hake were taken directly from net as soon as they arrived on deck and placed immediately on ice. About 100 to 200 pounds of hake from each catch were brought to the laboratory, where they were stored in a freezer at -40 C. The fish were used in a series of experiments within 3 weeks.

Product Preparation

A. Freeze-Dried Whole Fish

Because the nutritive value of raw fish is difficult to evaluate in feeding trials, we chose arbitarily to freeze-dry the fish. This technique would provide a product suitable for testing--yet one likely to be as similar to raw material as possible in chemical and nutritive characteristics.

Twenty-pound samples of the frozen whole raw hake were placed into liquid nitrogen and ground, first through a Rietz[1] extructor, and then through a Rietz disintegrator in a stream of liquid nitrogen. The ground particles, collected in liquid nitrogen, were loaded into freeze dryer in an excess of liquid nitrogen; then they were freeze-dried at pressure of 300 to 500 μ for 24 hours. During this period, the temperature of the platen was kept at 40 C. When drying was completed, the vacuum was broken with nitrogen. Then the samples were stored under nitrogen at -20 C.

B. Fish Protein Concentrate

Hake used for FPC production were from same catch as those used for freeze drying. Each production run consisted of 20 pounds of whole hake ground through a .25-inch end plate.

The solvent used for each test was fresh 91% (v/v) isopropyl alcohol. It was mixed with fish in a ratio of solvent to fish of 2 to 1. The slurry was stirred briefly and then transferred to extraction unit. After 30 minutes, the mixture was pumped to a basket centrifuge for separation of solids. The second extraction was made by running hot solvent distillate through the solids in centrifuge basket while centrifugation continued. This extraction was continued for 30 minutes at distillate temperature of 78 C. Centrifugation continued for another 15 minutes. The third extraction consisted of a continuous extraction of solids with isopropyl alcohol. (Described by Brown & Miller, 1969.) The liquid was removed continuously from extractor and evaporated, and the condensate pumped back to the extractor. After final separation of solids, the extracted material was desolventized under vacuum at 40 C. for 16 hours. The dried product was ground through a Wiley mill equipped with a screen having 0.5-mm openings.

Product Analysis

A. Chemical Analysis

Moisture, ash, and crude protein were determined by procedures of Association of Official Agricultural Chemists (1965). Lipids were determined by method of Smith, Ambrose, and Knobl (1964); amino acids by method of Moore, Spackman, and Stein (1964); and available lysine by method of Carpenter (1960).

B. Nutritive Evaluation

Samples of freeze-dried fish were fed in amount desired (ad libitum) to male albino rats (Charles River CD strain), randomly allotted to groups of 8 rats each. The samples were added to a nutritionally adequate basal diet at 10% level of crude protein (Campbell, 1960). The gain in weight and amount of food consumed were recorded each week for 4 weeks; the PER was then calculated.

RESULTS

Freeze-Dried Whole Fish

A. Chemical Analysis

Table 1 shows the proximate composition of freeze-dried whole fish at each sampling period. The freeze-dried raw material from each catch varied in its concentration of lipid and, to a slight extent, in its concentration of crude protein. In general, the concentration of lipid was lowest in October sample--9.8%. In contrast, samples of July, November, and January catches were 14 to 15%. Thus, the

[1]/Trade names are used merely to simplify descriptions; no endorsement of the products is implied.

Table 1. Proximate composition of freeze-dried whole red hake (*Urophycis chuss*) caught during 1964-65

Date of catch		Crude protein	Lipid	Ash	Moisture
		Wt %			
1964:	July	74.5	13.1	12.5	3.01
	October	76.7	9.7	13.1	2.74
	November	75.0	14.2	12.7	2.88
1965:	January	75.5	13.7	11.4	3.36

Note: The crude protein, lipid, and ash are reported on the basis of dry weight.

concentrations of crude protein and ash in October fish were slightly higher than these concentrations in the other samples.

Table 2 shows amino acid composition and available lysine concentration of freeze-dried samples. A comparison of all amino acids recovered, as percent of total crude protein, revealed that 83% (October) to 92% (January) of protein can be accounted for. Undoubtedly, other components of the nitrogen--such as various amines, ammonia, urea, creatine, taurine, and anserine--could make up this difference because there is a concentration factor from raw wet fish to freeze-dried product.

Thompson and Farragut (1965) reported an observation with whole alewives (Alosa pseudoharengus). They postulated that considerable metabolic energy is used when spawning commences, and that excretory processes of fish do not keep pace. So metabolic nitrogen products build up in the body.

In our study, although physiological condition of fish was unknown, the fish caught in October exhibited a slightly higher concentration of total nitrogen (crude protein) and lower concentration of amino acids than did other samples. The concentrations of amino acids did not reveal any marked changes during sampling periods; rather, they reflected changes related to an increase in total recovery as percent of the protein. The values obtained for available lysine fluctuated from period to period and, apparently, did not reflect any trend.

B. Nutritive Evaluation

Table 3 gives the mean total weight gain, food consumed, and protein efficiency ratio values from feeding trials of freeze-dried ground hake. The differences within each catch of fish were not significant, but differences between catches were highly significant ($P < .01$). The freeze-dried fish used in diets prepared from November sampling resulted in lower PERs than did other samples. To check accuracy of these data, we did another experiment (Nov. 1964B). The results confirmed previous test: protein quality was comparable to casein. The PERs obtained with diets made of freeze-dried fish from July, October, and January were better than those obtained with casein.

FISH PROTEIN CONCENTRATE

A. Chemical Analysis

Table 4 shows proximate composition of FPCs. The crude protein ranged between 85.5 and 88.9%. Very little difference was found in protein concentrations of FPCs produced from fish in July, October, and November--but concentration increased in FPC made from January fish.

Values for total residual lipid in FPCs show that removal of lipids by solvent-extraction procedure was not affected by the fish's physiological state. However, the composition of the residual lipids, which was not determined, may reflect differences.

Table 2. Amino acid analysis and available lysine of the standard reference samples: freeze-dried whole red hake (<u>Urophycis chuss</u>)

Amino acid	July 1964	October 1964	November 1964	January 1965
	Data for red hake caught on:			
	------------% of protein------------			
Available lysine	6.84	6.99	6.58	7.35
Total lysine	7.32	7.36	7.35	7.63
Histidine	1.91	1.78	1.91	1.92
Arginine	5.85	5.77	5.89	5.96
Aspartic acid	8.74	8.50	9.07	9.50
Threonine	3.82	3.68	3.98	4.07
Serine	3.86	3.75	4.00	4.08
Glutamic acid	12.67	12.62	13.64	14.05
Proline	4.52	4.09	4.27	4.57
Glycine	7.02	7.13	7.48	7.70
Alanine	6.08	5.67	6.11	6.50
Valine	4.61	4.31	4.59	4.88
Methionine	2.70	2.65	2.91	3.02
Isoleucine	3.86	3.71	4.00	4.21
Leucine	6.42	6.17	6.76	7.07
Tyrosine	2.76	2.62	2.83	3.01
Phenylalanine	3.57	3.31	3.70	3.82
Total	85.71	83.13	88.49	91.99

Table 3. Mean weight gain, food consumed, protein efficiency ratio (PER), and adjusted PER of animals fed freeze-dried ground whole red hake caught during 1964-65

Date of catch		Group	Tests	Rats/test	Weight gained Mean	Weight gained Standard error	Food consumed Mean	Food consumed Standard error	Protein efficiency ratio[1] Mean	Protein efficiency ratio[1] Standard error
			--------#--------		----------------g----------------					
1964:	July		6	8	159.7	2.5	377	2.0	3.39	0.04
	October		6	8	157.8	2.1	411	2.4	3.58	0.04
	November	A	2	8	131.8	2.0	419	3.1	2.90	0.03
		B	2	8	145.4	2.9	378	3.7	3.08	0.04
1965:	January		1	8	158.6	3.2	390	5.7	3.46	0.05

1/ The protein efficiency ratios were adjusted to a protein efficiency ratio of casein equal to 3.00.

Table 4. Proximate composition of FPC produced from whole fish caught during 1964-65

Date of catch		Crude protein	Lipid	Ash
		----------------Wt %	----------------	
1964:	July	86.2	0.4	14.2
	October	85.5	0.1	14.7
	November	86.1	0.3	14.6
1965:	January	88.9	0.2	12.9

Note 1: The data are on the basis of dry weight.

Note 2: Crude protein is calculated on the basis of N x 6.25.

The concentration of ash remained relatively constant (14%) for July, October, and November samples of FPC, but concentration in January sample decreased, which reflected the increase in protein.

To compare proximate composition data of FPC with those of freeze-dried whole fish, we had to place them on a moisture-free and lipid-free basis. When this was done, the values of crude protein in freeze-dried fish showed higher concentration in January than in other months. The same was true of ash concentration.

Table 5 lists results of amino acid analyses and determinations of available lysine concentrations in FPCs produced from raw fish caught during sampling periods. These data also show differences in percentage recovery, ranging from 96.0 to 102.0% of the protein. Most concentrations of amino acids either increased or decreased according to the recovery. Lysine, histidine, arginine, and proline, however, remained relatively constant. The concentration of available lysine fluctuated from period to period with no apparent trend.

In general, the major difference between amino acid concentration of FPCs, compared with that of freeze-dried samples, is the greater recovery, as percent of protein, from FPC samples.

B. Nutritive Evaluation

Table 6 shows results of feeding FPC diets to laboratory animals.

Table 5. Amino acid analysis and available lysine of FPC's produced from fish caught in different months of the year

Amino acid	July 1964	October 1964	November 1964	January 1965
	Data for FPC produced from fish caught on:			
	% of protein			
Available lysine	8.09	7.87	8.19	7.70
Lysine	8.28	8.23	8.31	8.31
Histidine	2.01	1.90	1.95	1.93
Arginine	6.70	6.78	6.69	6.77
Aspartic acid	9.75	9.67	10.61	10.49
Threonine	4.28	4.21	4.58	4.56
Serine	4.32	4.23	4.69	4.65
Glutamic acid	14.38	14.39	15.83	15.62
Proline	5.10	5.13	5.13	5.18
Glycine	7.52	7.62	8.46	8.72
Alanine	6.49	6.26	6.93	7.56
Valine	5.13	4.74	5.33	5.34
Methionine	3.11	3.22	3.44	3.43
Isoleucine	4.28	4.23	4.68	4.63
Leucine	7.16	7.16	7.88	7.85
Tyrosine	3.10	3.25	3.41	3.24
Phenylalanine	3.86	3.98	4.32	4.21
Total	95.47	95.00	102.24	102.35

Table 6. Mean weight gain, food consumed, protein efficiency ratio (PER), and adjusted PER of animals fed diets of FPC produced from raw fish caught in various periods of the years 1964-65

Date of catch		Group	Tests	Rats/test	Weight gained: Mean	Weight gained: Standard error	Food consumed: Mean	Food consumed: Standard error	Protein efficiency ratio[1/]: Mean	Protein efficiency ratio[1/]: Standard error
			#		g					
1964:	July		6	8	151.8	2.2	365	3.9	3.34	0.04
	October		6	8	139.0	2.0	412	2.9	3.09	0.04
	November	A	2	8	130.3	4.0	418	9.2	2.85	0.07
		B	2	8	141.5	3.8	363	6.4	3.12	0.05
1965:	January		1	8	154.0	8.6	363	12.0	3.62	0.12

1/ The protein efficiency ratios were adjusted to a protein efficiency ratio of casein equal to 3.00.

According to PER values obtained from feeding trials, the nutritive values of protein in FPCs processed from same catch of fish did not differ significantly. But a highly significant difference ($P < .01$) occurred in FPCs made from different catches. The FPCs processed from July and January fish were better than those prepared from October and November fish. Furthermore, the two latter groups were comparable only with casein, whereas the former two FPCs were better than casein. Compared with freeze-dried whole fish, the differences in PER from catch to catch were similar, with exception of October fish. In this instance, the freeze-dried sample had a significantly higher PER than FPC. At this time, we are unable to explain these results.

Chemical analysis revealed little information that could be related to nutritional data.

CONCLUSIONS

The results of tests over 6 months indicated certain aspects of FPC's nutritional value are affected by the raw material. Both freeze-dried samples of fish and FPCs prepared from same fish were found to have PERs comparable with casein, whereas PERs of other samples were superior to casein. Chemical analyses of the samples failed to yield any clues as to cause of this difference.

A longer study would have been useful in providing more detailed information on seasonal changes. However, this study has shown that, with one exception, the quality of FPC is no different from quality of raw material (or, at least, of freeze-dried raw material). Furthermore, it has shown that processing with isopropyl alcohol had no significant effect on nutritive value of raw fish.

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FPC

THE 1970 SALMON RUN

Joan Bergy

- - -

In June and July the run of Sockeye or Red salmon in western Alaska was one of the biggest in history. Fishermen brought in a catch of over 20 million of these fish, the second biggest since 1938. For the consumer it meant a bountiful national supply of the Reds, considered the tastiest of all canned salmon. To FDA's Seattle District and the salmon canning industry it meant weeks of careful planning and extraordinary efforts to bring this bounty quickly to the Nation's tables and assure its wholesomeness.

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Out of nowhere appears the cannery, on a long coastal inlet. Behind is Seattle and the flight from Juneau, over ragged snow-clad peaks, dense coniferous forests, blue water, innumerable islands, and an incredibly gapped coastline.

The float plane lands and taxis to the dock. Here in this remote location, far from any city, an FDA inspection is about to begin. A salmon cannery is near where the fish are. Some are in major coastal cities and towns, and some are completely isolated, like this one in Alaska.

The inspector's job, evaluating how the salmon is canned, is one of the most important consumer protection tasks he will ever perform. This FDA responsibility is one shared with the Alaska Health Department, the Oregon and Washington Departments of Agriculture (in their respective States), the National Canners Association, and the United States Army and Air Force.

The cannery is a self-contained village where all work and live together, from July to mid-September, while the salmon are surging up the inlets. Here fishermen and cannery workers of a dozen nationalities or races mingle in single-purpose activity. Families are housed in the cannery village; singles stay in dormitory-style bunkhouses. Groceries and supplies are sold at cost by the cannery store but prices are high because everything must be brought in by boat or float plane.

Radio is the link with the outside. Through it pass the cannery's communications with suppliers, charter flying services, other canneries, fishermen, headquarters offices, and even physicians. Oldtimers say they used to can salmon without radio communications, but today they wonder how they ever did.

The plant superintendent welcomes the FDA inspection. He remembers the year a team of inspectors came in before the season. Together they went through the cannery and talked about sanitation and improvements that the plant later implemented. Regular FDA inspections identify deficiencies in the operation. Inspectors' reports help the superintendent and cannery do a better job.

During the night tenders have collected the fresh-caught salmon from the fishing boats and delivered the cargo to the canneries. Salmon are unloaded into steps of a vertical conveyor belt from the hold of the tender. The inspector observes the way the fish are unloaded, the sanitation of the conveyors and flumes for transporting them, whether a cannery employee is monitoring the quality of raw salmon received, and whether decomposed fish are disposed of so they will not be processed for human food.

The conveyor moves the salmon into large bins in the fish house. With a little climbing and plank walking, the inspector reaches the rim of the bin to evaluate the quality of the fish lot.

What's a good fish? Condition and appearance of fresh fish are a shiny skin with an iridescent quality, bright clear eyes, bright colored gills, no odor or decomposition or slime, firm flesh, and a firm backbone with "no creaking."

Another indicator related to quality is water markings. Fish on the way to spawning

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grounds develop light-to-heavy water markings, or "mating colors." A Pink salmon flattens out, a hump forms on the back, and the color turns to dark olive. Chums change to a calico color, the jaw hooks, and the teeth stick out. The bodies of Sockeye turn red and the head becomes green. Salmon with moderate to heavy water markings produce a lower quality product that has less flavor.

Fish caught in gill nets have characteristic slash marks caused from swimming into the nets, catching their gills and strangling. Salmon caught in purse nets are not damaged and live until the net is drawn up like a purse string. Today the appearance and condition of the fish is judged to be good quality and the percentage of water-marked fish is low.

It's coffee time. The cannery people gather for coffee, rolls, and conversation, but the inspector stays behind to observe the wash-down of equipment and general cleanup that takes place while the crew is on a break.

Medium-sized canneries are equipped to process up to 75,000 fish a day during years of big salmon runs. Larger canneries can handle more, in some cases, as many as 125,000 salmon. Species of salmon vary in size: Kings, Silvers, and Chums may weigh up to 30 pounds; Sockeyes up to 8 pounds; and Pinks up to 6 pounds.

A bonanza run of 38 million Sockeyes in the Bristol Bay area in western Alaska during the seasonal run in June and July of this year produced a catch of over 20 million fish and 1,250,000 cases of canned salmon. The sizes of runs in other salmon-producing areas were average this year. The price cannery fishermen are paid for their catch depends on the world market and where the fish are caught. Prices for whole salmon may vary from ten to twelve cents a pound for Chums and Pinks to 25 to 50 cents or more for Sockeyes.

Back to the fish house. The salmon are lined up in tracks on a conveyor belt to pass through the guillotine, where the heads are removed. The egg sacs are pulled. In a separate operation, the eggs are dipped in a brine solution, salted, and packed in wooden containers for shipment to Japan as prized salmon caviar. Not many years ago the eggs were discarded. But now they are an important part of the operation and might bring as much as $5 a pound at retail in Tokyo. Even though the eggs are for export, FDA inspects some of the operations for sanitation.

The conveyor moves the salmon to the Iron Chink, an ominous machine that butchers the fish by slitting open the belly, removing the intestines and other organs, and lopping off the fins and tail. Before the invention of the Iron Chink in 1905, a fast "slitter" could hand butcher some 2,000 fish in a 10-hour day. Most people said then that a mere machine could not beat such a record, but one Iron Chink succeeded in replacing six slitters. Fish scales are removed by a brush and rinse operation. At the sliming table salmon are sorted into one group ready for canning and another for touch-up butchering and trimming.

When the salmon are butchered, the inspector looks for evidence of decomposition by smelling the insides, noting the firmness of the flesh, and evaluating its color. Decomposed fish become soft, the ribs and backbone separate from the flesh, the body wall turns red (termed "belly burn") and a strong fishy odor is present.

The inspector, whose mission is to protect the consumer, must keep in mind that the product moving through hands and equipment is food that will be eaten. Are aprons, gloves, plastic cuffs, and slickers kept clean by washing off with chlorinated water at intervals? Are workers' heads covered with hairnets, hats, or scarves? If pieces of fish fall on the floor, are they discarded or thoroughly washed before being returned to the processing line? Are cutting boards smooth instead of gouged or worn, and are they sanitized daily?

Wooden equipment is a potential enemy of sanitation, for it can harbor bacterial contamination. Are tables and bins constructed of stainless steel or other nonabsorbent material? Are all surfaces and utensils that come into contact with the product cleaned as frequently as necessary to prevent contamination? The inspector gives extra attention to these points.

It's time to can. But first, reforming machines are shaping the cans that soon will be filled with salmon. The cans are shipped flat, without lids or bottoms. The golden containers, now formed and bottoms fitted, are ready for salmon and file down a conveyor. Salt and perhaps salmon oil is added. The

slicer machine cuts salmon to size and the filler machine places it in the can. At some canneries the cans are weighed automatically and those that are underweight are rejected. At others the weighing is done manually. "Patch girls" add more salmon to the underweights, weigh them again, and send them on. Employees remove any bone or skin hanging over the sides of the cans. The tempo is fast. The lines at this cannery pack 240 to 250 cans per minute.

Clean machinery is one of the inspector's primary concerns. The inspector probes the interior of the filling machine in search of decomposed salmon or other filth. He checks to see if the plant has a written cleanup schedule and whether conveyor belts and machinery are thoroughly scrubbed and sanitized after each day's operation. If he observes decomposed fish, he can collect samples. If he notices unsanitary conditions, he will record it with his camera.

The sealing operation is critical. The can and cover are aligned in the lidder machine where the flared top of the can and the lid are loosely joined in the first step in making the top can seam. These cans are then conveyed into the sealer where the seam is completed under a vacuum. This final seaming operation presses out the seam and forces the sealing compound into the contact areas. The cans emerge from this machine with an internal vacuum and a seam that will maintain the contents commercially sterile. The old method of producing a vacuum was to punch a hole in the hot can after processing. Juice and steam would squirt high in the air. Then before the can cooled a drop of solder was placed over the hole. This primitive method was eliminated by a system of exhaust boxes which heated the open top cans. The invention of vacuum closing machines replaced the exhaust boxes.

Employees are required by the cannery rules to examine can seams at regular intervals and to keep records on their findings. The FDA inspector visually inspects seams on sealed cans by running a finger around the edge to detect roughness, unevenness, or sharpness. He examines different code lots and determines if there are any defective cans.

Gondolas or stacks of trays transport the sealed cans into large retorts for processing under steam pressure. The National Canners Association recommends processing times based on time-temperature studies designed to establish optimum conditions for producing a safe product. Half-pound cans are processed at 240° F. for either 75 or 80 minutes depending on whether they are to be air cooled or water cooled. Processing times are long to destroy any food poisoning organisms that might be present and also to soften the bones.

Each canning retort is equipped with continuous recording time-temperature thermometers and a standardized mercury thermometer. Retorting records and can-seam examination records for code lots are kept on file two years. The FDA inspector carefully reviews retort records because undercooked salmon may result in serious spoilage. Another check point for the FDA inspector is to ascertain if an employee is reviewing and endorsing all records at the end of processing of each code lot.

Cooling of the cans may be done in the retort with cold water or by air cooling outside the retort. All water used for cooling must contain one part per million residual chlorine to prevent possible recontamination of the sterilized cans.

Generally, cans are not labeled but are stored to await shipment from Alaska to ports in the contiguous States via barge or steamship. In cannery lingo, cans are shipped 'bright' (unlabeled). Depending on the cannery and the holding procedures used prior to canning, such as storage in ice, refrigeration, or freezing, it takes eight hours to several days for the salmon to make its way from the water to the inside of a can.

Some canneries generate their own electrical power and provide a water system, and all develop pest control measures and engineer waste disposal. The inspector is concerned with the operation of these systems as they affect the quality of the food produced.

The potability and constancy of the water supply is crucial because water is in contact with the fish throughout processing. The recommended practice is to use fresh water for the entire operation. In areas where water is in short supply, sanitized sea water is permitted during the preliminary operations in the fish house. After fish are butchered, fresh sanitized water must be

used. The inspector reviews the kind of water used, the operations of the chlorinator unit, the daily records on the level of chlorine residual in the water, and the construction of the water system.

Pests are controlled by several means, but screens, closed doors and windows, and buildings in good repair are the best deterrents of all. Inspections include review of the measures taken to exclude pests and a check for evidence of bird and vermin activity both inside and outside the plant.

Sewage disposal is checked for routes of possible contamination. Discarded fish parts, referred to as "gurry," attract pests when disposed of close to the shoreline. To solve this problem one cannery has a barge that collects solid gurry and several times a week the barge tows it out to sea and unloads it. Others grind it up and pump it out into the bay area. This problem of solid waste disposal is a major one the industry must solve before 1972 to meet Federal and State standards for water quality that go into effect at that time.

It's been a long day. The inspector and the plant superintendent sit down to discuss the inspection report. Because FDA's job is to assure that the food is processed under optimal conditions, the discussion focuses on deficiencies in the operation and plant improvements noted since the last inspection and other satisfactory conditions. The inspector supplies a list of his observations to the plant manager and invites discussion on any questions about his findings.

The inspection is over but the effort to provide the consumer with a quality product continues.

The Canned Salmon Control Plan, grandfather of all FDA voluntary compliance programs, made its debut 34 years ago. In the words of the National Canners Association, it is "an expression of a desire on the part of the salmon industry to improve the quality of its product and to restrain from the market any portion of its pack considered unmerchantable from any cause."

The plan represents a cooperative effort on the part of the Food and Drug Administration, the salmon canners, and the National Canners Association whereby the canners agree to submit their product to the scrutiny of the NCA for a determination of its fitness for food and FDA grants an exemption from technical requirements of the law by permitting unlabeled cans to be shipped to facilitate buyer labeling at distribution points.

Under the leadership of Franklin D. Clark, Regional Food and Drug Director, Seattle, and Walter Yonker, Director, Northwest Research Laboratory, National Canners Association, the plan calls for a minimum of one annual inspection of all member plants by FDA and NCA. Plants must meet minimum requirements as described concerning raw materials, plant sanitation, water supply processing, finished product, waste disposal, and sanitary and operational procedures.

If a plant is operating under conditions that do not meet these requirements as reported by the NCA or FDA inspectors, the Regional Food and Drug Director confers with NCA and the packer on the problems and if conditions warrant it the firm is suspended from the plan. A follow-up inspection is made to determine if improvements have been made. A plant may be reinstated if it meets the requirements of the plan; if not, the suspension continues and the product is subject to regulatory action by FDA. The consumer benefits from the twofold protection of the plan and the law.

This year, 78 canneries who produce more than 99 percent of the Nation's canned salmon are participating in this voluntary plan. The FDA's Seattle District expects to expend a total of six man-years of inspectional, analytical, and administrative time in carrying out its responsibilities under the plan and inspecting canneries that are not participating in the program.

Quality is the goal of the Canned Salmon Control Plan. In addition to inspections the Northwest Research Laboratory of the National Canners Association at Seattle examines representative samples of every code lot of canned salmon.

Check points in this evaluation include decomposition, can seams, measurement of vacuum, net weight of contents, ratings on color and amount of oil and liquid, presence of water markings and bruises or other handling marks, and evidence of poor cleaning or filling. The code lot is given a rating which serves as a "report card" to the cannery and to companies buying the product for their labels.

Is the plan working?

Over the years significant improvements have been made in the Canned Salmon Control Plan. Within the past three years the NCA has placed increased emphasis on finished product examination to pick up conditions, such as decomposition, that would make the code lot unmerchantable for any reason.

Statistics on the results of the NCA examination of every code lot demonstrate that the quality of the pack has improved.

FDA inspection reports indicate that the general level of sanitation has risen with the increased emphasis on cleanup schedules and procedures. Inspectors report a change in plant attitude: they say there is more awareness of the need for sanitation in all phases of the operation.

An estimated half-million dollars has been spent by industry on improvements in the past four years. Processing plants, once burdened with worn wooden equipment in years past, have become showplaces of the industry.

The record is still not perfect, but in the words of Mr. Clark, "We have a lot less trouble now than before."

During 1970 some 65 to 75 million salmon are expected to be harvested from the waters of Alaska, Washington, and Oregon. If the catch materializes, 3.75 million cases of canned salmon will be produced to stock the shelves of every grocery store in America.

Results of Northwest Research Laboratory's Examination of Canned Salmon

	Total Pack In Cases	Number of Cans Examined	Number of Cases Reconditioned	Number of Cases Destroyed
1967	3,225,000	167,272	12,448	2,324
1968	4,100,000	303,040	18,642	1,948
1969	3,250,000	167,393	6,395	13

SURFACE TUNA-SCHOOL FISHING & BAITING AROUND SAMOA ISLANDS

Thomas S. Hida

The NMFS research vessel 'Charles H. Gilbert' returned to Honolulu on April 14, 1970, after completing a series of offshore and inshore surveys around the Samoa Islands. One of her primary missions was to survey the distribution and abundance of surface tuna schools through visual observations, trolling, and live-bait pole-and-line fishing. In the vicinity of the islands, 144 schools were seen. These included 28 skipjack tuna, 11 yellowfin tuna, and 10 mixed yellowfin-skipjack tuna schools.

Most of the observations and all of the live-bait fishing were carried out during the offshore surveys. Baiting was carried out in conjunction with live-bait pole-and-line fishing.

Other objectives accomplished by the 'Gilbert' included: (1) collecting blood samples from 216 skipjack tuna, Katsuwonus pelamis, and 26 yellowfin tuna, Thunnus albacares, for subpopulation studies; (2) making thirteen 30-minute surface plankton tows with a 1-meter net for larval tuna studies; (3) tagging and releasing 840 skipjack and 91 yellowfin tunas for growth and migration studies, and (4) conducting 35 inshore bottom fishing stations and a few miscellaneous stations in cooperation with the Government of American Samoa.

Because reports dealing with baiting and pole-and-line fishing near Samoa Islands are scarce, the cruise findings regarding these operations are presented in detail. (The results of the four other objectives will be reported elsewhere.)

OFFSHORE SURVEY

Pole-and-Line Fishing

A total of 144 schools was sighted in the area covered by two offshore surveys (fig. 1). In most instances, schools were accompanied by bird flocks composed of a few to over 1,000 birds. Birds most commonly associated with the schools were terns, boobies, and shearwaters. Schools sighted were identified as: 28 skipjack tuna, 11 yellowfin tuna, 10 kawakawa, Euthynnus affinis, 10 mixed yellowfin and skipjack tunas, 1 mixed kawakawa, dolphin, Coryphaena hippurus, and shark (unidentified), and 84 unidentified. The locations of the schools, with dates, are given in table 1. Many schools seen were not investigated because they were too far away, too fast or too small; more schools would have been fished had there been more live bait available. Sixteen schools were successfully fished. The catch included 1,075 skipjack tuna (4 to 17 pounds), 160 yellowfin tuna (2.5 to 60 pounds), and a few other fish. The locations of the tagged tuna releases are indicated with a "T" in figure 1.

Only 12 of the schools sighted were estimated to be large. Information on these schools, estimated to be over 50 tons, is given in table 2. Five were "breezers," six were "boilers," and one, which was loosely schooled over a wide area, was designated as a "jumper" (see Scott,[1] 1969 for school descriptions). Activity of the "boilers" was not intense, with fish breaking surface only in small patches in pursuit of forage. Six of the schools had 5-10 pound skipjack tuna, two schools were of 20-50 pound yellowfin tuna, and four were mixed schools of 5-11 pound skipjack tuna and 5-60 pound yellowfin tuna. Locations of the large schools are indicated in figure 1 with an "X".

Trolling

Surface trolling was conducted with four lines during most of the daylight runs. Identification of schools and size of fish were often determined by troll-caught fish, especially during the second offshore survey when there was a shortage of live bait aboard the

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1/ "Tuna Schooling Terminology," James Michael Scott. Calif. Fish Game 55(2): 136-140. 1969.

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Table 1.--Noon Positions, Dates and Number and Kinds of Schools Sighted Around the Samoa Islands During Cruise 117 of the 'Charles H. Gilbert'

Noon Position		Date	Number of Schools Sighted[1]						
Lat. (S.)	Long. (W.)	1970	SJ	YF	KK	Mixed YF, SJ	UN	Mixed KK, DO, SK	Total
12°00'	169°15'	2/8	-	-	-	-	4	-	4
South of Pago Pago		2/11	-	-	-	-	5	-	5
16°55'	170°45'	2/12	2	1	-	-	4	-	7
16°03'	170°13'	2/13	4	-	-	-	2	-	6
14°33'	170°23'	2/15	2	-	-	-	2	-	4
14°30'	169°22'	2/16	-	1	-	1	3	-	5
13°37'	169°24'	2/17	-	-	-	-	1	-	1
14°09'	171°00'	2/23	-	-	1	-	2	-	3
14°27'	171°45'	2/25	1	-	-	-	-	-	1
13°49'	173°15'	2/26	-	3	-	2	4	-	9
13°50'	172°08'	2/27	-	-	2	-	3	-	5
14°12'	172°12'	3/1	1	1	1	1	1	-	5
14°45'	171°02'	3/2	1	-	-	-	5	-	6
14°19'	170°36'	3/5	-	-	-	-	3	-	3
14°18'	170°35'	3/6	-	-	-	-	4	-	4
14°19'	170°39'	3/10	-	-	1	-	1	-	2
14°17'	170°53'	3/11	-	-	1	-	-	1	2
14°51'	170°30'	3/14	2	-	-	-	1	-	3
14°11'	170°14'	3/18	-	2	-	-	4	-	6
14°02'	169°22'	3/19	-	-	-	2	4	-	6
14°39'	168°36'	3/20	4	-	-	1	2	-	7
14°38'	170°14'	3/21	3	-	-	-	5	-	8
14°25'	170°47'	3/23	3	-	-	-	4	-	7
15°42'	170°45'	3/24	-	-	-	-	2	-	2
14°23'	170°35'	3/25	-	-	-	-	1	-	1
14°15'	170°56'	3/26	2	1	1	1	4	-	9
13°46'	171°45'	3/27	-	-	-	-	2	-	2
13°42'	173°08'	3/28	1	1	-	-	3	-	5
14°15'	172°29'	3/29	-	-	1	-	5	-	6
13°44'	171°50'	3/31	-	-	2	2	1	-	5
15°03'	171°16'	4/1	2	1	-	-	2	-	5
Total			28	11	10	10	84	1	144

[1] SJ = skipjack; YF = yellowfin; KK = kawakawa; UN = unidentified; DO = dolphin; SK = shark.

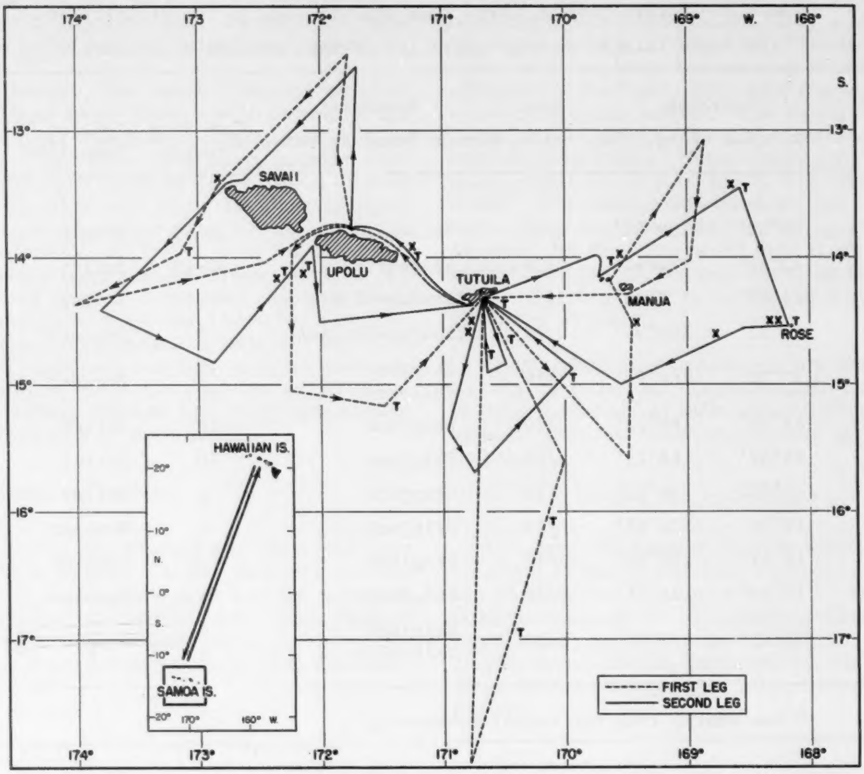

Fig. 1 - Offshore survey track chart, 'Charles H. Gilbert' cruise 117, January 30-April 14, 1970, showing locations of tag releases "T" and large schools "X."

'Gilbert'. The troll catches included 46 skipjack tuna, 30 yellowfin tuna, 31 kawakawa, 2 dolphin, and 1 shortbill spearfish, Tetrapturus angustirostris.

Environmental Conditions

The surface temperatures recorded by expendable and mechanical bathythermographs around the Samoa Islands during the survey ranged between 28° and 30° C. The thermocline depths were usually 30 to 60 meters ranging from 20 to 78 meters. The thermocline was not as "sharp" as that encountered in the Equatorial Countercurrent and the eastern tropical Pacific. Temperatures were typically 25°-27° C. at a depth of 100 meters; 20°-23° C. at 200 meters; and 15°-16° C. at 300 meters. The weather changed rapidly in the area, with seas mostly moderate and winds usually blowing from points between northeast and southeast. The water color was the typical deep blue of the open tropical Pacific.

Transported Bait

Prior to leaving Honolulu, 135 buckets of threadfin shad, Dorosoma petenense, were loaded into three baitwells aboard the 'Gilbert' for use as live bait in pole-and-line fishing. The shad had been acclimated to sea water and were held in swimming pools for several months prior to the cruise. Shad mortalities were high during the rough 10-day voyage to Samoa. Only 30 buckets survived, but these worked well as chum during the first offshore survey for as long as they were available.

Table 2.--Information on Large Tuna Schools Seen in the Vicinity of the Samoa Islands During Cruise 117 of the 'Charles H. Gilbert'

Position Lat. (S.)	Position Long. (W.)	Date 1970	Species Common Names of Tuna	Fish Size Pounds	Type of School[1]
14°30'	169°21'	2/16	Yellowfin	20-50	Boiler
13°25'	172°45'	2/26	Yellowfin	30-40	Boiler
14°09'	172°11'	3/1	Yellowfin-Skipjack	7-16	Boiler
14°12'	169°35'	3/19	Yellowfin-Skipjack	5	Breezer
13°30'	168°41'	3/19	Skipjack Yellowfin	11 60	Breezer
14°39'	168°25'	3/20	Skipjack	10	Boiler
14°37'	168°25'	3/20	Skipjack	10	Boiler
14°45'	168°51'	3/20	Skipjack	6	Boiler
14°26'	170°42'	3/23	Skipjack	8	Breezer
14°27'	170°46'	3/23	Skipjack	7-8	Breezer
13°54'	171°21'	3/26	Skipjack	5	Breezer
14°12'	172°04'	3/31	Skipjack Yellowfin	6 9	Jumper

[1] See Scott, 1969 for school terminology.

INSHORE BAIT SURVEY

Tutuila, American Samoa

Bait scouting was conducted from the shore in Tafuna, Alofau, and Fagasa Bays. Baiting conditions were poor in all three localities and suitable baitfish scarce. Therefore, baiting was confined to Pago Pago Harbor. A night light was submerged a few feet below the sea surface whenever possible in Pago Pago Harbor in depths ranging from 13 to 20 fathoms. Only eight sets with a lampara net were made around the light. No set was made unless an accumulation of baitfish was seen under the light.

A total of 54 buckets of a mackerel, Rastrelliger kanagurta, 22 buckets of sardines, Sardinella melanura and Herklotsichthys punctatus, and 4 buckets of bigeye scad, Trachurops crumenophthalmus, was caught night baiting. Small jacks, silversides, mullets, and a few other fish were also caught. Juvenile bigeye scad were not caught in large quantities, although it was the most common fish hooked by natives in the harbor.

Most Rastrelliger and sardines were 5 to 7 inches long and were considered too large to be an effective live bait for small skipjack tuna. Problems were encountered in trying to keep Rastrelliger alive in the baitwells. On two occasions, after a few hours in the baitwells, they began surfacing in convulsive movements, turned on their sides and sank to the bottom. Mortality was very high and believed to be the result of oxygen deficiency. Unlike the other bait species, this larger baitfish could not be crowded into the baitwells.

Thirty-one sets were made with a bait seine (22 feet deep by 80 fathoms long) in 8 days of baiting in Pago Pago Harbor. Eighty-eight buckets of sardines, the most prevalent species, were caught; the largest catch in one set was 20 buckets. A few silversides, juvenile jacks, surmullets, mullets, anchovies, tangs, and puffers were also caught in the seine. A few attempts to set on Rastrelliger during the

day in the deeper parts of the harbor were unsuccessful because they swam under and out of the seine before it could be pursed.

In summary, the most common baitfish found in Pago Pago Harbor with possibilities as a live bait was Rastrelliger, followed by sardines. The harbor was deep, mostly over 13 fathoms, and offered fairly good baiting conditions. Day seining for Rastrelliger would probably be more effective using a seine 30-40 feet deep. At the time of the surveys, most Rastrelliger and sardines were larger than desired as chum for small skipjack tuna. It is assumed that they would have been smaller and more suitable as live bait had the survey been conducted a few months earlier. Also, smaller ones may prefer areas other than Pago Pago Harbor and may have eluded detection during this survey.

Upolu, Western Samoa

In Western Samoa, bait scouting was limited to Apia Harbor. Little bait was evident around the main dock area and the adjacent shoreline, but the shallower and sandier grounds along the northwestern shores of the harbor appeared more suitable for baiting.

Observations under night lights showed a scarcity of suitable baitfish. Only a few mullet and schools of tigerfish (Theraponidae), which were too large for use as live bait, were attracted to the light. Five daytime seine sets were made in the harbor. The catch included 13 buckets of large (3-4 inch) silverside, tentatively identified as Hepsetia pinguis (Lacepède), and 5 buckets of small (2.5-inch) sardines. The silverside died in the baitwell before they could be used for fishing, probably affected by the long skiff ride from baiting area to vessel. The sardines, on the other hand, did very well in the baitwell and were effective as chum.

Baiting was poor in Apia Harbor during the survey. Further scouting should be conducted in other areas and at different times to better assess the live-bait resources of Western Samoa.

ACKNOWLEDGMENTS

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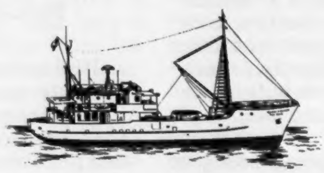

AIRBORNE LOW-LIGHT SENSOR DETECTS LUMINESCING FISH SCHOOLS AT NIGHT

Charles M. Roithmayr

The National Marine Fisheries Service (NMFS) is aware of the need for new and improved methods of assessing fish stocks. Fishery data are inadequate because they have produced wide-ranging population estimates. Systematic appraisals of world fish stocks vary from 55 to 2,000 million metric tons; obviously, this wide range is not suitable for management purposes.

NMFS presently assesses fish stocks from samples caught by research and commercial vessels. The evasive behavior of fish caused by vessels and gear often results in considerable bias of the catch rate. Stock assessment is difficult because the samples are collected with few vessels in a small area over a long period. The most reliable assessments are based on collections over a large area in a short time. Any new assessment method requires more accurate and rapid detection. All indications point toward use of remote sensors to collect the information required to assess and manage the Nation's fishery resources.

Detection of pelagic fish schools from aircraft is well established in the world's commercial fishing. In Florida, spotters often fly as low as 300 feet to detect Spanish mackerel schools that blend with coral bottom and submerged vegetation. In California, night and day operations ranging 125 miles or more offshore are conducted with single-engine aircraft. During the dark of the moon, the fish spotter may remain in the air from dusk until dawn searching for luminescing schools of tuna and anchovy (Squire, 1961 and 1965). Airborne remote sensors are needed that can rapidly detect fish schools day and night.

REMOTE SENSORS

Remote sensors are instruments that extend man's visual abilities far beyond normal range. With radio telescope, he explores objects far out in space. Television cameras mounted in satellites can spot a hundred-foot object on earth from 500 miles. By extending his senses with such devices, man can locate targets that he cannot observe directly.

NMFS scientists at the Exploratory Fishing and Gear Research Base, Pascagoula, Mississippi, in cooperation with National Aeronautics and Space Administration (NASA) Spacecraft Oceanography Project, are testing airborne sensors to detect and identify fish schools in daylight and at night (Peace and Drennan, 1969; Drennan, 1969; Benigno, 1970).

The sensors include aerial cameras (Bullis, 1968; Bullis and Pease, 1968), spectrometers to measure reflectance spectra of fish schools and associated fish oils (Bullis and Thompson, 1970), and low light sensors to detect schools from high altitudes at night. Background information on bioluminescence and the results of tests with low-light sensors are presented here.

BIOLUMINESCENCE IN THE SEA

Bioluminescence is light produced by living animals and plants comprising thousands of species of marine organisms, including plankton. The lanternfishes and euphausiid shrimp that predominate in the deep scattering layer possess luminous organs.

Direct observations and the use of sensitive underwater photometers reveal the universal occurrence of bioluminescence in the oceans. The phenomenon occurs in all temperate seas, particularly during warm season. It occurs more often and with greater intensity throughout the year in tropical and subtropical seas. Studies in the Atlantic and Indian Oceans, and in the Mediterranean Sea, have shown luminescent organisms always present

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where measurements were made with underwater photometer (Clarke and Wertheim, 1956; Clarke and Breslau, 1959; Clarke and Kelly, 1964).

The major concentrations of luminescing organisms are in the upper 100 meters, usually within the lighted zone, and in waters where most pelagic fishes abound. Population densities of luminescent organisms vary considerably. The maximum concentration reported for Phosphorescent Bay, Puerto Rico, was 7,600 cells per liter (Clarke and Breslau, 1960); cell densities as high as 220,000 per liter were found in Oyster Bay, Jamaica, in the West Indies (Seliger, Fastie, Taylor, and McElroy, 1962). The luminous dinoflagellate, Pyrodinium bahamense, is the most abundant organism in both bays.

Most bioluminescence in the sea is caused by dinoflagellates that emit light when stimulated. The light is produced by a biochemical reaction catalysed by a specific enzyme in the presence of water and oxygen. Light-emitting luciferin is oxidized by the enzyme luciferase, and some luciferin molecules absorb energy and thereby reach excited state. When stimulated, each molecule of luciferin releases one photon (unit) of light. If sea water is stirred, the luminous discharges of individual microorganisms look like sparkling crystals. If the water is agitated rapidly, the points of light emitted by dinoflagellates fuse into a bright glow. Turbulence resulting from the swimming motion of fishes provides the mechanical stimulation that outlines their bodies with light, and leaves behind a luminous trail.

What Low-Light Sensor Achieves

Visual observations and feasibility tests using an airborne low-light sensor during moonless periods show that: 1) bioluminescence associated with fish schools makes the schools conspicuous; 2) the perimeter of the school is usually well defined; and 3) the school is detectable to sensor and television camera from aircraft at 5,000 feet.

Potential applications of low-light sensor include detecting herring, sardine, mackerel, and tuna schools at night on traditional grounds where luminescing schools are known to occur; observing the reaction of fish to bioluminescence associated with fishing gear; and to make "real-time" observations as part of a remote sensing system in exploratory fishery-resource assessment.

PRACTICAL SIGNIFICANCE OF BIOLUMINESCENCE IN COMMERCIAL FISHERIES

1. Pacific Sardine (Sardinops caerulea)

Bioluminescence has been used in detection and capture of sardine schools off the U.S. Pacific Coast. Once the most important fishery in the western hemisphere, it is now under a moratorium due to the absence of commercial concentrations. The greatest catch occurred in 1936-37: 790,000 tons landed. It is still fished off Mexico's Pacific coast.

The sardine schools are located by their luminous glow during moonless periods. Before the new moon, fishing occurs from one hour after sunset until moonrise and, during the new moon, from one hour after sunset until one hour before sunrise. Following the new moon, fishing is done from moonset until one hour before sunrise. On the average, 19 nights are fished during each lunar period during sardine season. Before new moon, good catches are made from one hour after sunset until moonrise; after new moon, the best fishing occurs immediately after moonset (Scofield, 1929).

The seiner passes close to the glow to assess school's extent and density. Identification of species is determined by luminescent trails left by individual fish darting from vessel. Sardines show long rocket-like streaks, smelts swim in "S"-shaped curves, and anchovies display short spurts (Higgins and Holmes, 1921).

The lampara seine used is particularly efficient because its webbing stimulates organisms to luminesce as it is pulled through water. The fish, frightened by bright glare associated with fibers, are herded into bag. As wings are pulled in, a "scarer" consisting of several paddles on a long rope is raised and lowered through the water. The luminescence produced by the whirling paddles frightens fish away from net opening, thereby preventing their escape.

2. Skipjack (Katsuwonus pelamis), Yellowfin Tuna (Thunnus albacares), Bluefin Tuna (T. thynnus)

In the eastern Pacific, luminescing schools of skipjack, yellowfin, and bluefin tuna are sighted by spotters aboard tuna purse-seine clippers during dark of the moon.

Table 1. Summary of Commercial Fishes Detected by Luminescence

	East Pacific	West Africa	Gulf of Mexico	Gulf of Maine
Coastal:	sardine (Sardinops caerulea)	sardine (Sardinella aurita)	thread herring (Opisthonema oglinum)	herring (Clupea harengus)
	anchovy (Engraulis mordax)	herring (Sardinella eba)	Spanish mackerel (Scomberomorus maculatus)	mackerel (Scomber scombrus)
	mackerel (Scomber japonicus)	mackerel (Scomberomorus maculatus)	bluefish (Pomatomus saltatrix)	butterfish (Poronotus triacanthus)
	smelt (Atherinopsis californiensis)		menhaden (Brevoortia patronus)	menhaden (Brevoortia tyrannus)
	saury (Cololabis saira)		ladyfish (Elops saurus)	
	jack mackerel (Trachurus symmetricus)		bluerunner (Caranx crysos)	
			tarpon (Megalops atlantica)	
Oceanic:	bluefin (Thunnus thynnus)	yellowfin (Thunnus albacares)		
	yellowfin (Thunnus albacares)	skipjack (Katsuwonus pelamis)		
	skipjack (Katsuwonus pelamis)			

	Mediterranean Sea	Caribbean Sea	Australia	North Sea	Indian Ocean	South Africa	Philippine Islands
Coastal:	sardine (Sardinella aurita)	sardine (Sardinella either anchovia or brasiliensis)	pilchard (Sardinops pilchardus)	herring (Clupea harengus)	mackerel (Rastrelliger kanagurta)	pilchard (Sardinops ocellata)	sardine (Sardinella fimbriata)
	mackerel (Scomber scombrus)					maasbanker (Trachurus trachurus)	

All lights, except for navigation, are extinguished while searching. The spotter in crow's nest periodically flashes a high-powered spotlight over the water. When beam passes over a school, disturbance of the fish causes a bioluminescent glow called a "fireball" (Scott 1969). Generally, the glow is uniform throughout school. "Popper" refers to a fireball school in which brilliant bursts of light are caused by activity of individual fish. Before purse seine is set, the fishermen identify the species--because anchovy and jack mackerel also cause bioluminescence. The large luminescent outlines usually distinguish tuna from other fishes.

More Susceptible to Night Capture

The logbook records of Pacific tuna purse seiners show that luminescing schools of skipjack, yellowfin, and bluefin tuna were more susceptible to capture at night (Whitney, 1969). Only 50 to 54 percent of daylight sets were successful, while night sets ranged from 69 to 77 percent. The average night catch of yellowfin tuna during dark of the moon is about the same as during the day, about 14 or 15 tons per set. Off southern California, spotter pilots rely on bioluminescence to detect tuna schools between September and June. At night, they fly only when moon is dark, before the moon rises, or when moon is overcast. As verified by ship sonar, schools have been seen from aircraft as deep as 35 fathoms.

3. Atlantic Mackerel (Scomber scombrus)

In the Gulf of Maine, bioluminescence helps purse-seine fishermen detect and catch mackerel. Luminescent patches associated with moving schools are visible at depths to 10 fathoms during moonless periods (Sette, 1950). Fishermen scouting at night can identify at least four species according to type of luminescence. Long brilliant streaks indicate Atlantic mackerel, starlike flashes identify butterfish, bright zig-zag lines characterize Atlantic herring, and a dim glowing sphere is recognized as a school of Atlantic menhaden.

4. Atlantic Herring (Clupea harengus)

Maine stop seine fishermen are most active at night when searching coves to locate herring by their "fire". They follow the luminous trails until the school enters a shallow inlet, where it can be trapped.

5. Spanish Mackerel (Scomberomorus maculatus)

During night fishing in Florida coastal waters, the vessel cruises at 5 knots in areas where luminescing schools of Spanish mackerel are likely to be seen. The captain periodically flashes a spotlight, and the fish show the "fire" produced by their sudden movements. Catches of 10,000 to 20,000 pounds per set are not unusual.

6. California Anchovy (Engraulis mordax)

Off California, schools surface at night and are visible as luminous spots (Messersmith, Baxter, and Roedel 1969). The schools expand as dawn approaches. Night catches up to 160,000 pounds per set have been made using purse seines.

7. Thread Herring (Opisthonema oglinum)

Spotter pilots have seen large luminescing schools of thread herring as far as five miles off Florida's southwest coast.

DEVELOPMENT OF LOW-LIGHT SENSORS

Research by the U.S. Army Electronics Command on night-time search and identification of enemy targets has produced the starlight scope. Unlike the infrared sniper scope, it needs no light of its own. It uses only natural light (moonlight, starlight) or the faint luminescence of decaying jungle foliage. It amplifies light 40,000 times and transforms darkest night into day. The heart of the starlight scope is the image-intensifier tube (Fig. 1), which consists of several bundles of very thin glass fibers. Each fiber transmits light in a straight line down length of fiber, which prevents both distortion and leakage. The scope's objective lens focuses the light against a chemical film that discharges electrons. These electrons, boosted by a 15,000-volt electrostatic field, impact onto a phosphor-coated screen whose light then loosens additional electrons. The process is repeated three times. The high-voltage electron acceleration produces a brighter image at the ocular lens. The only power source is a small built-in battery.

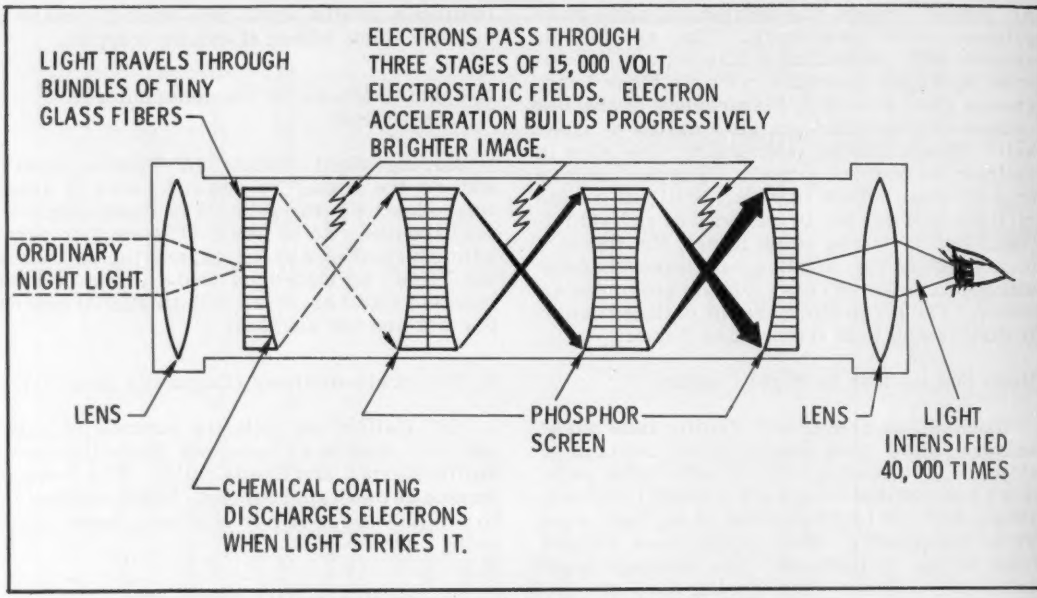

Fig. 1 - Diagram of image intensifier tube of starlight scope.

NMFS PASCAGOULA RESEARCH

During October 1968, tests were conducted at Port St. Joe, Florida, aboard a commercial seiner. The starlight scope was used to detect bioluminescence associated with Spanish mackerel schools during dark of the moon (Fig. 2). With scope coupled to a closed circuit television camera, the image of luminescing school was recorded on video tape (Fig. 3). Figures 4 and 5 show each moving fish outlined by light around its reflective body, which is followed by a luminous trail. The trail is produced by stimulation or organisms in turbulent wake of the fish.

Fig. 2 - Spanish mackerel captured following tests with starlight scope.

During dark of the moon, in January and February 1969, luminescing fish schools were recorded on video tape with SANOS (stabilization airborne night observation system) scope and closed-circuit television. Data were recorded from a Grumman Albatross

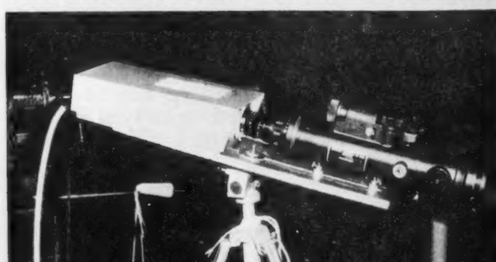

Fig. 3 - Starlight scope coupled to television camera.

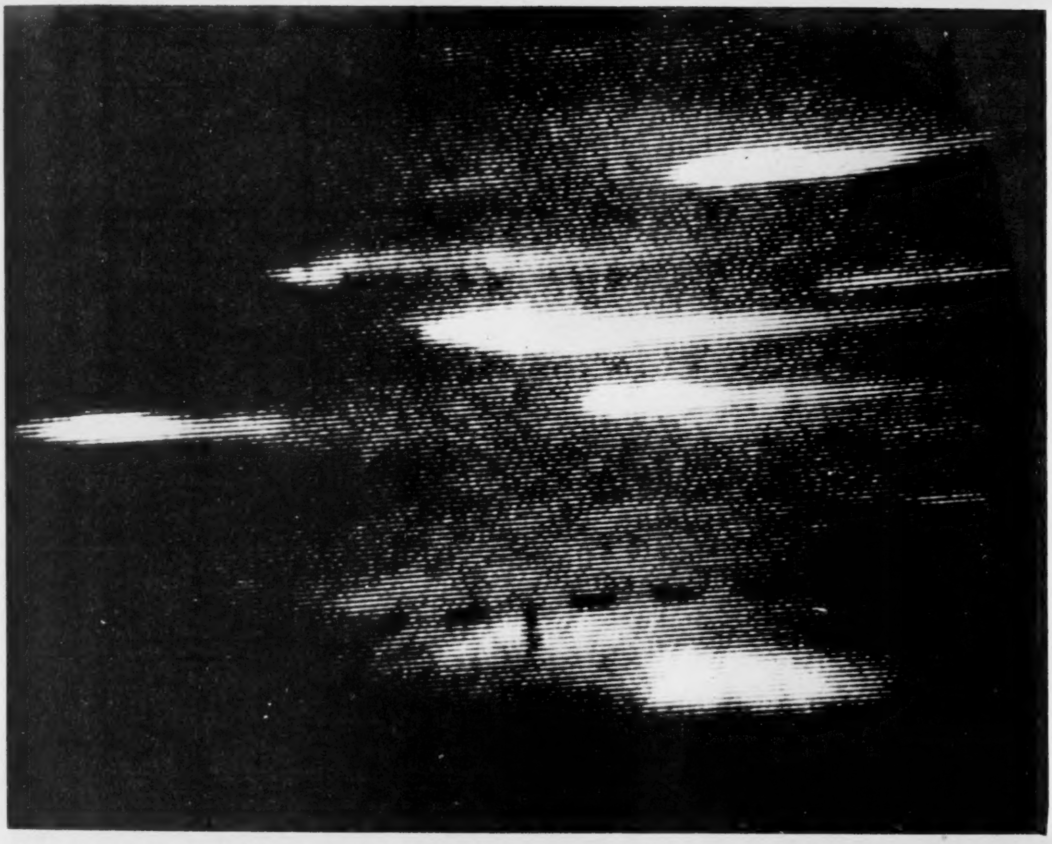

Fig. 4 - School of Spanish mackerel showing associated bioluminescence as detected with star light scope and seen on television screen. School is 5 to 10 feet below surface; its distance from sensor is about 50 feet.

Fig. 5 - A Spanish mackerel outlined by definite field of light around body.

and a helicopter stationed at St. Petersburg, Florida, Coast Guard Air Base. A commercial fish spotter was chartered to spot schools of thread herring during daylight over commercial fishing grounds off Sanibel Island, Florida. A search of the same area at night revealed luminescing schools near surface. At altitude of 3,500 feet, a luminescing school was amplified by the low-light sensor before appearing on television screen (Fig. 6). The width of crescent-shaped school was estimated by spotter pilot at 150 feet. Night aerial search near Ft. Myers Beach, Florida, revealed an elliptical school with long axis of about 500 feet (Fig. 7). Sporadic flashes in school probably were caused by nocturnal predators, such as shark or tarpon. Luminescing schools were detected in same general area during three consecutive nights.

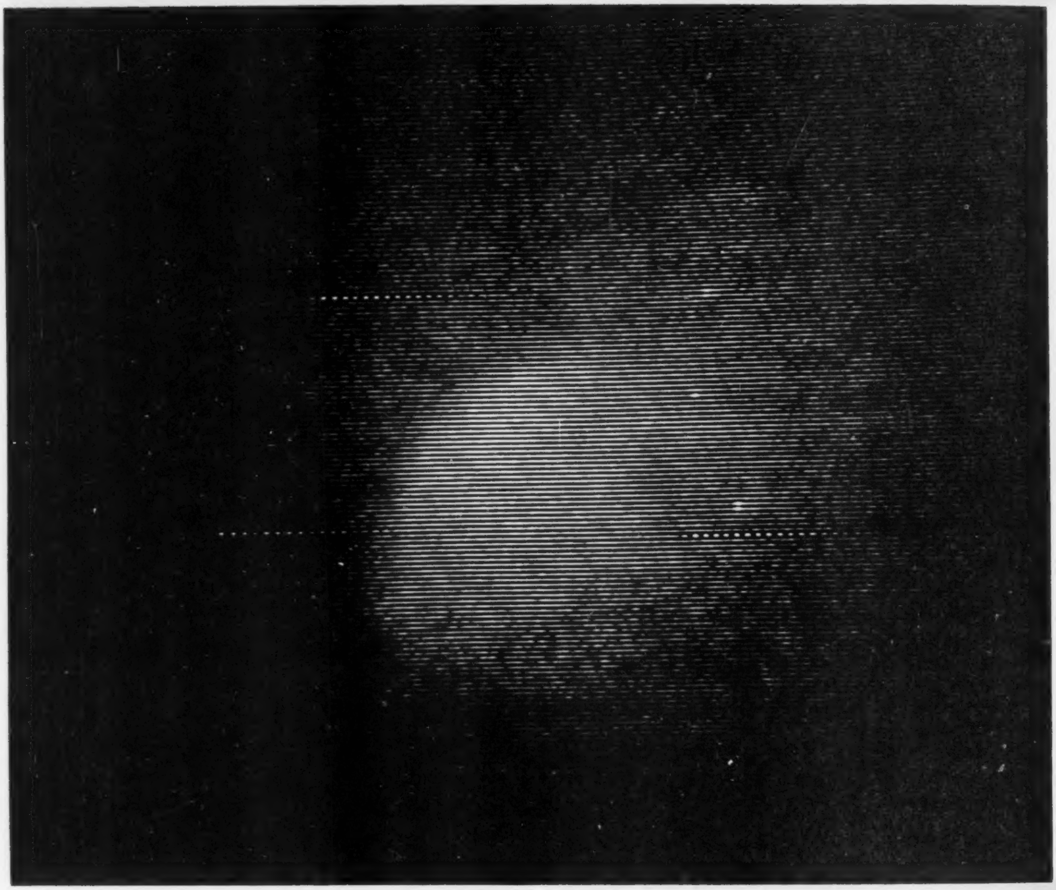

Fig. 6 - A school of thread herring 150 feet in diameter spotted from the aircraft at 3,500 feet. The faint luminescence was amplified by lo-light sensor before appearing on TV screen shown in photo.

With SANOS scope in helicopter (Fig. 8), several schools about 300 feet wide were sighted off Sanibel Island from 500 to 5,000 feet altitude. The luminescence was visually intense from spotter aircraft at 2,000 feet as helicopter videotaped school at 500 feet. The glow was brilliant despite twilight and early morning haze, probably because helicopter noise frightened school.

Visual and low-light-sensor observations during moonless nights show that:

1. Bioluminescence makes school conspicuous.

2. Perimeter of school usually is well defined.

3. The school is detectable to sensor and television camera from 5,000 feet.

Results show that low-light sensors can detect fish schools invisible to naked eye at night.

APPLICATION OF LOW-LIGHT SENSORS TO FISHERIES & RESEARCH

Low-light sensors may be applied in two ways:

1. As direct fishing aid by mounting sensor and television camera in crow's nest of a purse seiner, with television screen in pilot house. Then the captain could detect herrings, sardines, mackerels, and tunas at night where schools are known to occur. Airborne sensors would shorten search time, increase successful sets, increase catch per day, and reduce vessel trip time. For daylight fishing of menhaden, tuna, and thread herring, detecting the schools before sunrise would provide advance information on concentrations. Data indicate that purse-seine sets during early daylight hours produce larger catches than at other times.

2. Probably more important application of low-light sensors would be as a prime sensor in fishery research. Scientists are concerned with schooling behavior at night. Observations of bioluminescence with the unaided eye are insufficient to determine what influence

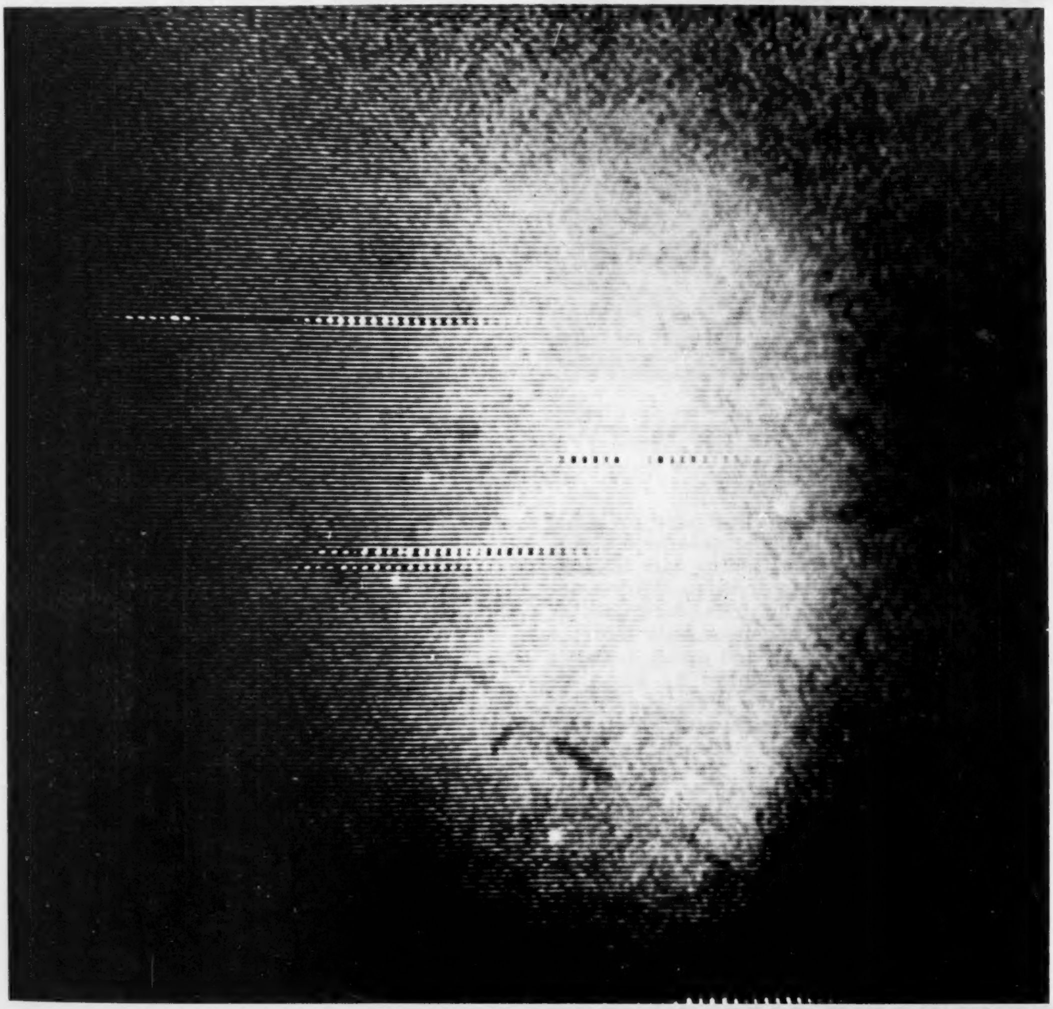

Fig. 7 - A large luminescing school of thread herring 500 feet in diameter amplified by airborne low-light sensor. Flashes inside school may be preadators attacking from below.

Fig. 8 - SANOS scope mounted in hatch of Coast Guard helicopter used as survey aircraft during fish-school detection tests. TV camera is coupled to the scope's eyepiece. TV monitor is in lower right corner of photo facing operator.

it has on the school. Luminescence invisible to unaided eye would be detectable with highly sensitive sensor. Night fishing with Isaacs-Kidd midwater trawl has confirmed presence of associated cone of luminescence (Boden, 1969). Photometric measurements indicate that amount of light ahead and inside trawl is greater than that above or below it. The low-light sensor can detect the reactions of fish to luminescence associated with the trawl, which also may provide new insights on night midwater trawling.

The airborne sensor can greatly assist in resource assessment by providing "real-time" observations of number and size of schools. Also, it would rapidly record data for analysis and interpretation by computers. This new technology would supply reliable information on status, size, movements, inventory, and forecast of traditional and new stocks in large areas on a time scale not now possible.

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COLLECTING COASTAL PELAGIC FISHES WITH ARTIFICIAL LIGHT AND 5-METER LIFT NET

Donald A. Wickham

The National Marine Fisheries Service (NMFS) Exploratory Fishing and Gear Research Base, Pascagoula, Mississippi, has used underwater lights and a large-diameter lift net to attract and capture live coastal pelagic fishes for experimental studies. The gear design and fishing methods evolved from our observations of the behavior of coastal pelagic fishes around underwater lights, and their responses to conventional lift nets. This article provides details for building and rigging the 5-meter (16.4 feet) diameter lift net--and the mounting platform used to position underwater lights and an echo sounder transducer over the net. The methods of fishing this gear and handling the live fish are described.

Artificial lights have been used to attract fish at night for capture with a great variety of fishing gear. Light-attraction techniques in the world sardine fishery were reviewed by von Brandt (1960). The Japanese have used hand-held dip nets and lift nets to capture light-attracted saury. Recent developments in Japanese night-light fishery were reported by Anonymous (1968). Borisov (1956) described equipment and fishing methods of the Soviet Caspian Sea fishery in which lift nets are used to harvest light-attracted sprat. Methods for collecting and keeping live clupeoids for experimentation were described by Verheijen (1956), who obtained his specimens from ring nets around night lights in the Mediterranean Sea. In Gulf of Mexico, Siebenaler (1953) collected various live tuna-bait fishes with an $8\frac{1}{2}$-foot square trap lift net and 150- or 300-watt light. Recently, personnel of the Exploratory Fishing Base at Pascagoula have used several types of high wattage lights and a 5-meter (16.4 feet) diameter lift net to capture numerous coastal pelagic species for experimental studies.

FISH BEHAVIOR & LIFT NET DESIGN

Prior to designing the light attraction and lift net shown in Figure 1, a variety of light sources and net designs were used at night-lighting stations in the Gulf of Mexico. Fish were attracted to almost every type and intensity of light used. A bright-point source light, with a well-defined intensity gradient, created a better organized or structured aggregation than did a dispersed field of light created by several sources. Maeda (1951) described the structure of the communities around fishing lights in Japan. Most coastal pelagic fishes attracted to artificial light in Gulf of Mexico also exhibited preferential spacing within light field, probably in relation to light intensity. Many of these fishes did not accumulate directly beneath light but occupied dimmer zones. Fish would move to center of light field when light was dimmed gradually.

To capture as many fish as possible from the dim light zones, the lift net was designed with the largest hoop that could be operated from research vessel's outrigger. The large opening improved catch because the hoop would often reach the level of the fish before they could detect it.

Fish in the path of a rising net escape by rapidly dispersing horizontally and/or sounding obliquely out of the path of the approaching net. Several features of the net may have reduced the fright stimulus produced

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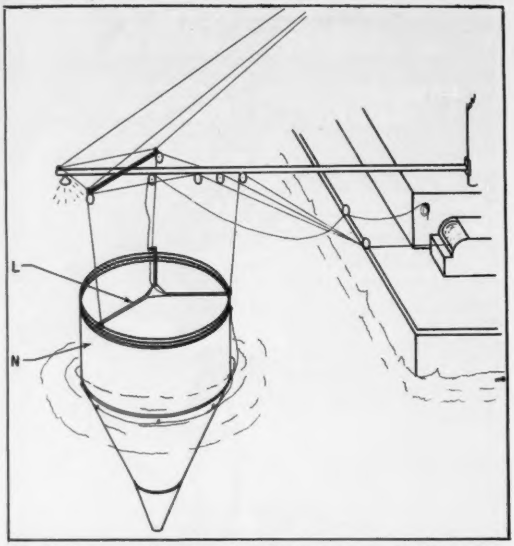

Fig. 1 - Diagram of design and rigging for the 5-meter lift net (N) and the underwater lamp and echo-sounder transducer mounting platform (L).

during fishing. The net was rigged with 3 separate lift lines because a bridle caused a fright response and the fish evaded capture. The 3 lift lines produced some vibrations during a lift, but they did not elicit fright reactions--and the fish were not much disturbed before visually detecting the net. The visual fright stimulus produced by the net's approach was reduced by making the top 10-foot section of webbing hang straight down from hoop before tapering to cod end. Although pressure wave that precedes rising net was not measured, the straight-side design also may have reduced this pressure wave, or lowered it to within the net opening.

LIFT NET HOOP DESIGN

The lift net hoop was made by rolling a 2- by 2- by $\frac{1}{4}$-inch angle iron and a 1-inch iron pipe to a 5-meter (16.4 feet) diameter circle and welding the iron pipe to the angle iron. The hoop was constructed in 2 equal parts bolted together with overlapping angle-iron stiffeners (Fig. 2). This construction permits hoop to be dismantled for easy storing.

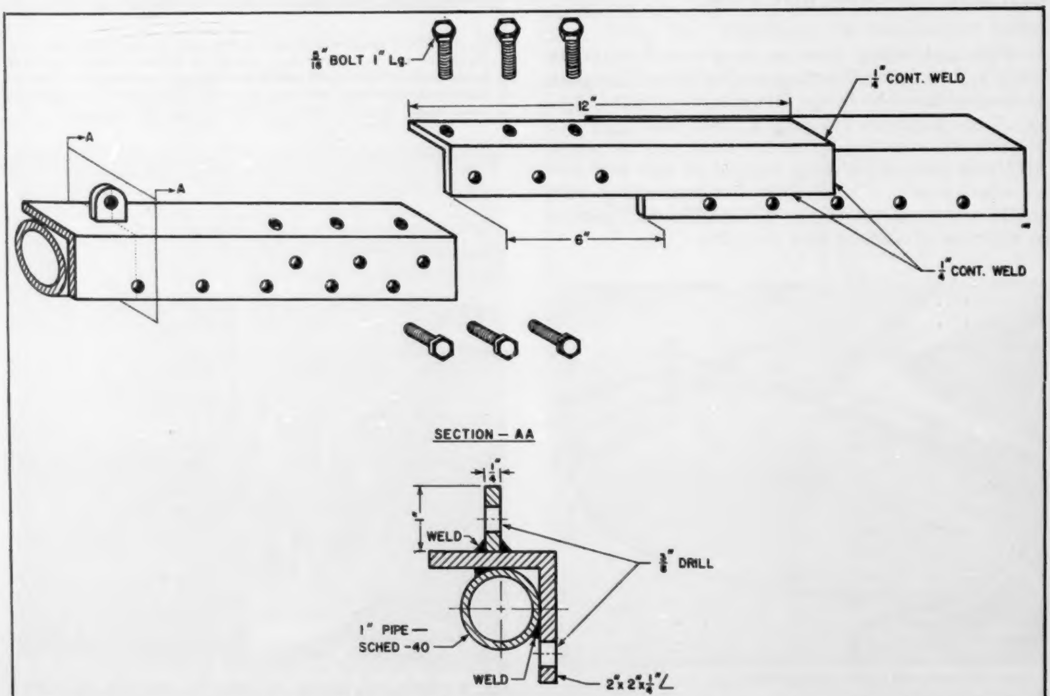

Fig. 2 - Design and construction of lift-net hoop frame. Upper diagram shows method of bolting together the hoop's two halves. Cross section of lift-net hoop frame (Section AA) shows details of angle iron and pipe frame, lift-line pad eyes, and net-attachment holes.

The hoop's lower flange was drilled with $\frac{3}{8}$-inch holes spaced at 3-inch centers for net attachment. Lift lines were attached to 3 pad eyes equally spaced on hoop's top flange.

LIFT NET RIGGING

Operation of a lift net with 3 separate lift lines, instead of a single line bridle, required special rigging to put a block directly above each lift point. The rigging's general layout is shown in Figures 1 and 3. A specially built yard arm was bolted across end of vessel's outrigger to space and support the blocks for the two outboard lift points. The inboard block was attached directly to outrigger. The yard arm is 15 feet long of 2-inch schedule 80 iron pipe; it is supported by guy wires leading to tip of outrigger and to top of main mast. The lift lines run from net hoop through series of 4-inch blocks that bring lines together and lead through a single 6-inch snatch block to vessel's main winch. The lift lines are attached at winch and wrapped together around drum. Lift lines are 75-fathom lengths of $\frac{5}{16}$-inch stainless-steel wire rope.

The net hoop can be suspended directly from yard arm and outrigger by short lengths of chain joined by large Brummel hooks (Fig. 4). This support rigging allows outrigger to be raised to vertical with net attached because lift lines are not holding weight of net and can be slackened. Capability for traveling with net in vertical position facilitates navigation in narrow channels and docking (Fig. 5).

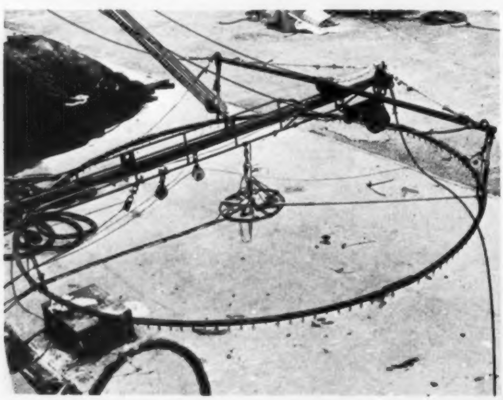

Fig. 3 - Rigging of outrigger and yard arm for deployment of 5-meter lift net. Details of net hoop and lift line rigging are shown with prototype model of underwater light mounting platform.

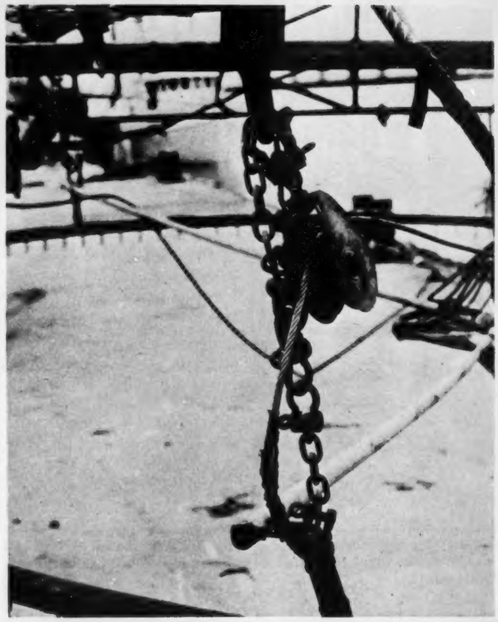

Fig. 4 - Short lengths of chain suspend lift net hoop directly from outrigger and yard arm when net is not in use. Large Brummel hooks connect chains for quick attachment and release of hoop. The slack-wire rope-lift line, a 4-inch block, and one prototype underwater light mounting platform arms also are shown.

Fig. 5 - George M. Bowers departing on collection trip with 5-meter lift net suspended from port outrigger. The net hoop was attached to outrigger and yard arm (see Fig. 4) permitting lift lines to be slackened and outrigger raised to clear dock.

NET DESIGN

The net was made of $\frac{1}{2}$-inch stretched-mesh knotless nylon webbing dyed dark green. It was strengthened at seams with nylon tape (Fig. 6). The opening was 5 meters (16.4 feet) in diameter. The top 10 feet of webbing were hung from hoop with a straight fall, whereas remaining section tapered to the cod end. The 28-foot total length provided sufficient slack for cod end to be hoisted aboard vessel for emptying. Rings for choker lines were sewn into net around cod end and in other appropriate areas. An iron weight was attached to cod end to sink webbing during fishing. Grommets were placed at 3-inch centers in band of dacron sewn around top of net. Small Brummel hooks attach net to hoop and permit quick installation and removal of webbing for storage out of the sun (Fig. 7).

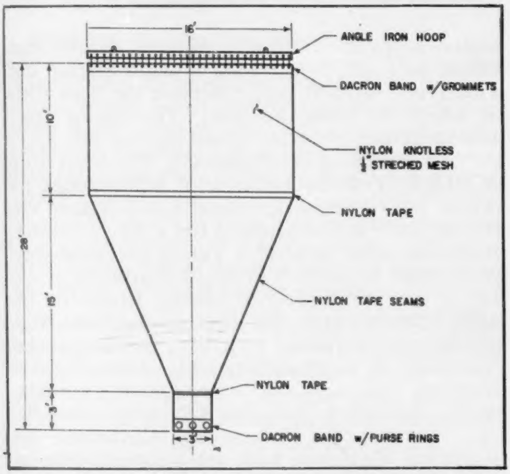

Fig. 6 - Diagram of lift net showing measurements and major design features.

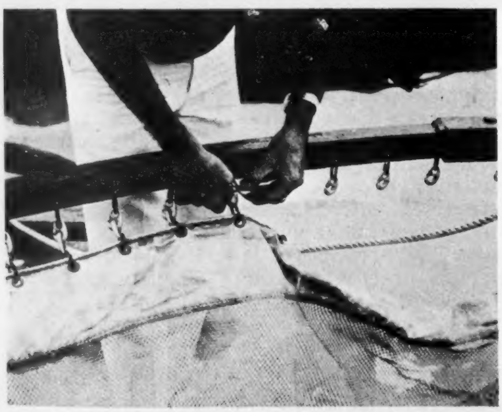

Fig. 7 - Small Brummel hooks attach the net to the hoop and quick removal of the net for storage out of the sun when not in use.

LIGHT SOURCES & UNDERWATER MOUNTING PLATFORM

The first light-attraction source was a 1,000-watt quartz-iodide lamp mounted on vessel's outrigger and directed downward above net. Although this lamp attracted fish successfully because of its mounting location, its light zone and attracting ability were considerably reduced by vessel's hull. Reflection from water surface also reduced lamp's efficiency, especially when seas were choppy.

Fish aggregations were monitored originally by an echo sounder using vessel's hull-mounted transducer. Transducer's location proved unsatisfactory for detecting fish near surface and directly over lift net.

Various arrangements for positioning an underwater light and echo-sounder transducer above lift net were evaluated before satisfactory design was developed. This design, described below, consists of a mounting platform braced by 3 arms that extend to lift lines (Fig. 8). Platform is suspended from outrigger by a line used to position it at any selected depth below surface. Figure 3 shows

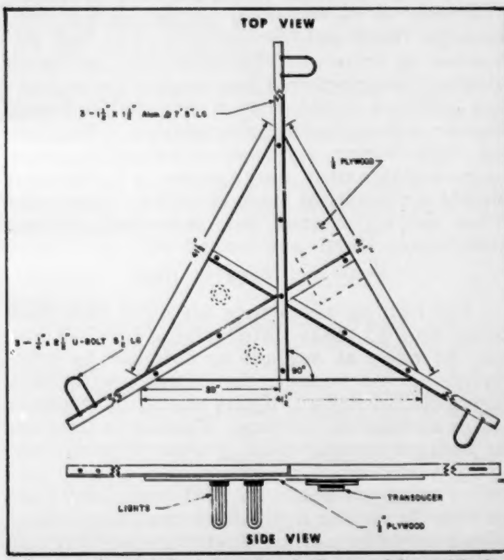

Fig. 8 - Design details of mounting platform used for positioning underwater lights and echo-sounder transducer over lift net.

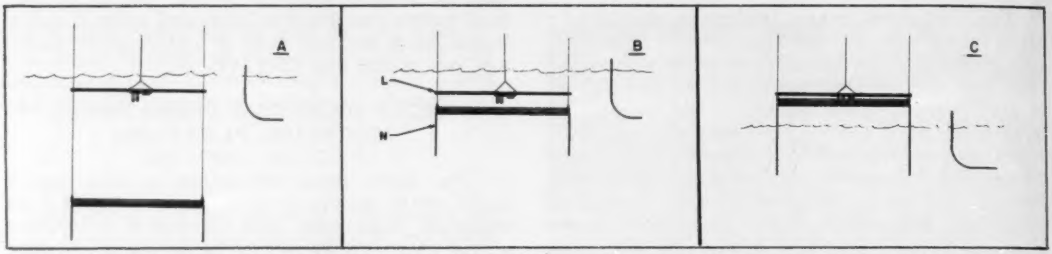

Fig. 9 - Diagram shows sequence of events during a net lift; A - Lift net and underwater light mounting platform in fishing position, B - During a lift, the lifting lines pass through hoops on mounting bracket as net moved upwards until net hoop reaches and contacts arms of mounting bracket, C - The net hoop and mounting bracket begin moving upward together, both emerging from water at same time. (N) Lift net. (L) Underwater light mounting platform. Fig. 1 shows the lift net and light mounting bracket in position C.

a prototype platform suspended over net hoop. Final mounting platform was constructed of $1\frac{1}{2}$- by $1\frac{1}{2}$- by $\frac{1}{4}$-inch aluminum angle. Mounting platform is centered over net by 3 arms that are attached loosely to lift cables by u-bolts, through which lift cables can move freely.

The arms prevent platform from flipping when vessel rolls. A widely spread bridle attached to arms also adds to stability. Vertical movement is dampened but not eliminated with this device. During a net lift, the lift lines move through u-bolts in arms of mounting platform, but the platform does not move until net hoop contacts tips of arms. From moment of contact, arms rest on net hoop and mounting platform is raised with lift net so that they emerge from water together. The lift sequence is shown in Figure 9. The mounting platform supports a 1,000-watt mercury vapor lamp, a 1,000-watt quartz-iodide lamp, and an echo-sounder transducer. Because the underwater lights must be extinguished immediately after emergence, a 1,000-watt quartz-iodide flood lamp, which is suspended from outrigger over net, is turned on when underwater lights are turned off.

FISHING PROCEDURE

The fishing procedure involves selection of an area of clear water where fish schools can be seen at surface or detected by echo sounder. At sunset, the vessel, with deck lights off, anchors or drifts on station depending on current conditions. The net is lowered to desired depth, usually near bottom, and underwater lamps are positioned usually just below vessel's keel. At keel depth, the light is equally visible in all directions; the transducer is near enough to surface so that fish accumulating beneath lights can be detected. The underwater mercury vapor lamp is turned on, and the echo sounder monitored until a satisfactory accumulation of fish is indicated. Prior to a lift, the vessel's main engine and winch are turned on to permit the fish time to adapt to these sounds. The underwater quartz-iodide lamp is turned on, and the mercury-vapor lamp extinguished. The light field is slightly reduced because of differences between the lights in spectral composition and efficiency--and because of the water's attenuation characteristics. A variable transformer is used to permit gradual dimming of underwater quartz-iodide lamp. Dimming the light concentrates the fish around the light and over the net prior to a lift, and it reduces visibility of approaching net. After light is dimmed, the net is lifted as quickly as possible. The hoop of rising lift net passes fish and contacts arms of mounting platform. The mounting platform and net hoop emerge together. The quartz-iodide lamp, suspended from outrigger, is then turned on, and the underwater light extinguished. The surface light retains the fish not captured in the general area for capture on following lifts. The surface lamp also provides light for handling catch without turning on deck lights. If two nets were fished, the alternate net and light would be deployed from the opposite outrigger at this time. After removal of the catch, the net and platform are lowered back to their respective positions, the underwater lamps are turned on, and the surface light is extinguished. The procedure described above is repeated until a sufficient quantity of fish is captured.

Other Best Catches Made

Best catches with the lift net and light attraction were made in the summer around dark of the moon in clear calm water. The most productive night times for fishing were in the early evening and predawn hours. The latter period usually produced larger and

denser aggregations. Visual and echo-sounder observations and lift net catches indicated reduction of fish aggregations in light field during midnight hours. Peak periods in catches could be caused either by increased susceptibility of fish to light attraction, or by changes in light-intensity preferences resulting in greater dispersion around light even though fish continue to be attracted. Experimental fishing with more efficient gear (purse seine) would be necessary to evaluate these hypotheses.

HANDLING TECHNIQUES FOR LIVE FISHES

Methods of handling live coastal pelagic fishes depend upon the species. The hardy fishes (scaled sardines, Harengula pensacolae; round scad, Decapterus punctatus; rough scad, Trachurus lathami; and chub mackerel, Scomber colias) are removed from lift net through cod end, which is quickly swung on deck and emptied into water-filled plastic tubs. The catch is then hand sorted into the large transportation tanks. When catch is large, only a small part is brought aboard at one time to prevent injury to fish.

The delicate species (Spanish sardine, Sardinella anchovia; round herring, Etrumeus teres; Atlantic thread herring, Opisthonema oglinum; and anchovies, Anchoa spp.) are removed by dumping catch back into mouth of net, where the fish are removed by dip net. The dip nets have small mesh ($\frac{1}{2}$-inch stretched mesh) knotless webbing, which causes less injury to fish than knotted netting. Sometimes, a plastic liner is used in dip net for extremely delicate species. The fish removed in small batches with the dip net either are placed in tubs for sorting, or are introduced directly into the transportation tanks if the catch consists mostly of the desired species.

On the stern of the 'George M. Bowers' are two portable 1,500-gallon rectangular fiberglass tanks for transporting live fish (Fig. 5). Each is divided into two compartments by a removable wood-and-fiberglass screen. The divider keeps several species separated; it also acts as a baffle by reducing water sloshing caused by vessel's roll. Fewer fish probably would be injured in cylindrical transportation tanks or tanks with rounded corners than in rectangular tanks.

During transport at sea, the tanks are supplied with a constant flow of fresh sea water and, though often crowded, the fish survive well. Upon entering harbors or other areas of doubtful water quality, the tanks are shifted from the flow-through system to the recirculating system powered by a small portable pump. Recirculation keeps fish alive for short periods, but survival time is prolonged when water is cool and the fish are not crowded.

Immediately upon return to the Base, the fish are removed from transportation tanks by dip net and transferred in water-filled plastic tubs to sea-water laboratory (Wickham, MS). In laboratory, the fish are placed either into holding tanks or into the large experimental pool. Temperature and salinity shock is minimized by gradually introducing the fish into the system.

The equipment and techniques described here have supplied the Exploratory Fishing and Gear Research Base at Pascagoula, Mississippi, with fish for controlled field and laboratory studies. These techniques also could be adapted to supply live bait for commercial and sport fisheries.

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THERMAL POLLUTION OF COLUMBIA RIVER MIGHT THREATEN SMELT

George R. Snyder

The smelt, or eulachon (Thaleichthys pacificus), fishery of the Columbia River and its tributaries is unique. The fish are caught commercially in the mainstem with gill nets, but commercial and sport fishermen are allowed to use dip nets in the tributaries.

Smelt are an accessible item for the winter dinner table. They are relatively easy to capture in the tributaries, and the commercial harvest provides a timely income. The 1968-69 harvest (1,120,000 pounds) was worth more than $280,000; the economic value of the sport fishery was estimated at $570,000. The 1969-70 winter season was estimated to have equalled or exceeded the 1968-69 catch.

Most smelt enter the Columbia River in late November or early December, when the river temperature averages 45° F. If the temperature varies above or below normal, schools act erratically: They are delayed, migrate farther upstream, or simply fail to enter their spawning tributaries.

The Columbia River smelt is anadromous. The adults spawn in fresh water but spend most of their life cycle in salt water. The major tributary spawning occurs in the Cowlitz River, but runs have been observed in the Lewis and Kalama Rivers (see figure 1). In past years, smelt were common in the Sandy River and migrated as far upstream as Cascade Locks in the Columbia River. The distribution of schools of smelt in the Columbia River is not well known; some are found between Puget Island and Vancouver. Schools enter tributary streams to spawn, but some remain in the mainstem. The 1969 season was a cold-water year, so the Cowlitz River run was delayed. The 1970 season was another atypical year in the Cowlitz. The run was delayed, but extensive runs ascended the Lewis River during April.

Apparently the males move into the tributaries first. Smelt spawn at 3 to 4 years, and most die soon after. Spawning occurs primarily at night.

Deposit Demersal Eggs

Female smelt deposit demersal eggs: eggs that sink slowly toward bottom. A female of average size produces about 25,000; the range possibly is 7,000 to 60,000 eggs.

The eggs are adhesive and surrounded by double membranes. As the egg settles and touches an object, the outer membrane ruptures and attaches to the substrate--usually to sand grains or debris. The inner membrane contains the embryo.

The eggs are not attended by the adults. Development takes about 3 weeks at 47° F.--from time of deposition to hatching of fry. The fry emerge from egg "shell" with yolk sac attached. They are about 4 millimeters long (6 fry placed end on end would measure one inch). The fry are weak swimmers and must leave fresh water and enter salt or brackish water soon after hatching. They are swept along with river current. Sensitive to light, they stay near bottom during downstream migration to the ocean.

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Article is updated version of one that appeared in 'Oregon Sportsman' in July 1969. With permission of magazine.

COMMERCIAL FISHERIES REVIEW
Reprint No. 899

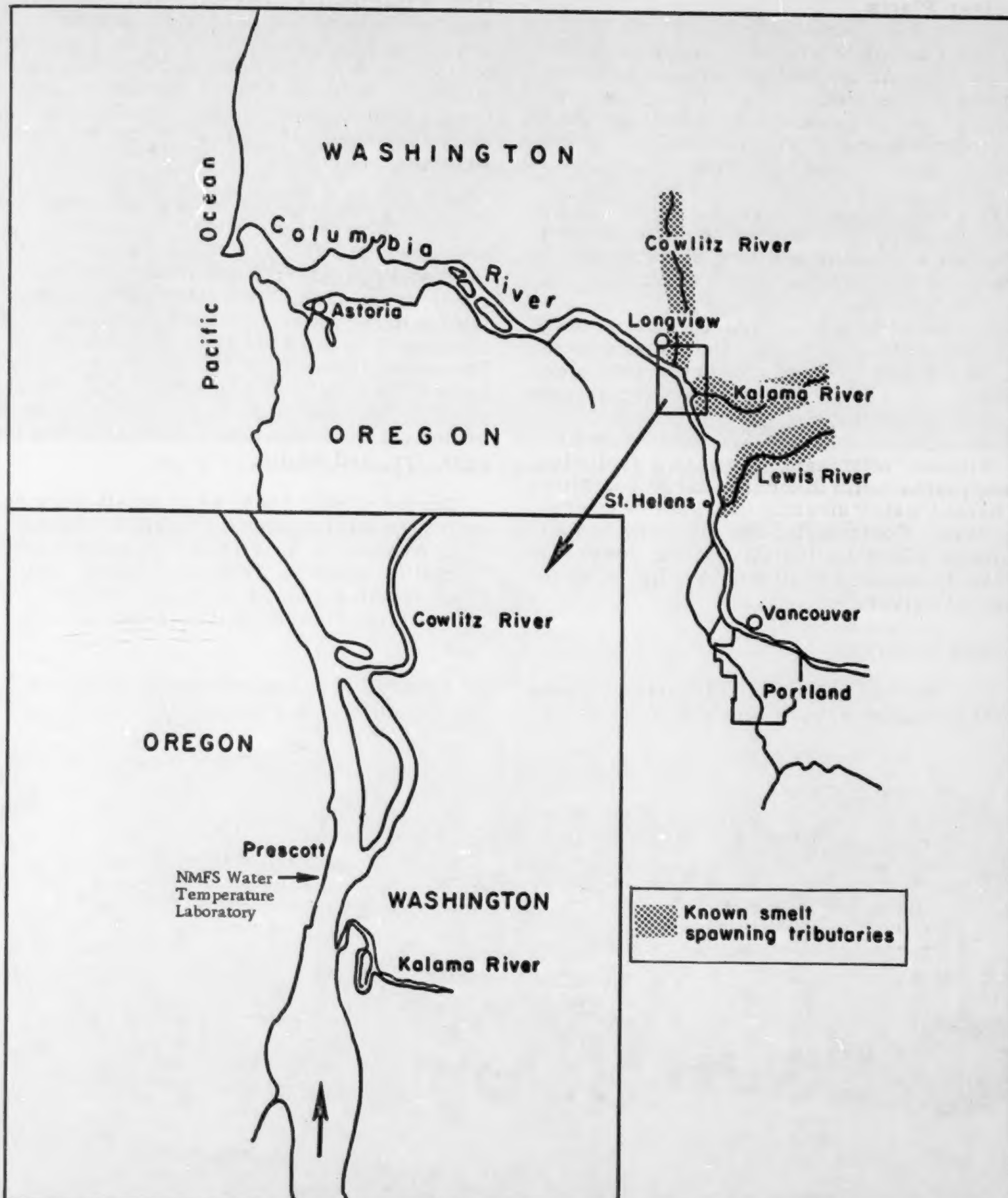


Fig. 1 - Location of smelt spawning areas in relation to NMFS water temperature laboratory.

Nuclear Plants

Smelt seem to require narrow ranges of water temperature. Recent industrial development in this section of the river, however, has led to proposals for installing large thermal nuclear electric plants. These plants can alter local river temperatures.

Two such plants proposed for above Cowlitz River lie directly in migration route of smelt that ascend Kalama and Lewis River and of other anadromous species in Columbia.

Thermal nuclear plants require large quantities of water to cool their condensers. For each unit of heat converted into electricity, two units of heat are ejected into adjacent waterways.

Without "offstream" cooling facilities, these plants could discharge large quantities of heated water directly into path of migrating fish. Fortunately, one company has announced plans to install cooling towers to prevent discharge of all but 15 c.f.s. of waste heat into river.

Studies Underway

The National Marine Fisheries Service (NMFS) initiated an investigation to determine what effect temperature increases would have on aquatic animals and plants between Kalama and Longview, Wash. NMFS is cooperating closely with State and Federal agencies to investigate effects of thermal pollution on anadromous fish such as salmon, trout, sturgeon, shad, and smelt in the Columbia River.

During August 1967, a covered barge was towed to Carter's Marina, Prescott, Oreg., and converted to a modern aquatic research laboratory to determine thermal tolerance of anadromous fish. The laboratory uses Columbia River water, cooling or heating it with chillers or heaters in a once-through system. Fish are taken with purse seines, beach seines, trawl nets, and dip nets. The fish are subjected to increases in water temperature to determine lethal and sublethal levels for eggs, fry, and adults.

During winter 1968, adult smelt were examined to determine their thermal tolerance. Fish exposed 1 hour to 16° F. suffered 50% mortality after a 32-hour holding period. Most females placed in water heated 7° F. above river temperature failed to deposit eggs.

Tests were conducted during 1969 to verify preliminary observations that adult smelt

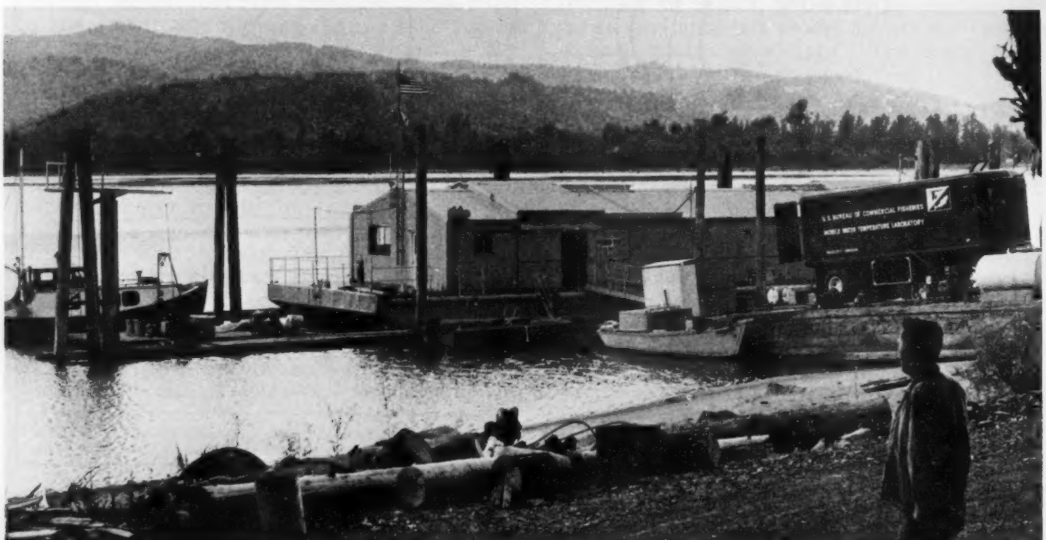


Fig. 2 - NMFS Water Temperature Laboratory on Columbia River--$\frac{1}{4}$ mile below proposed Trojan thermalnuclear electric plant site. (Photo: Robert K. Brigham)

Fig. 3 - Technicians collecting smelt from Cowlitz River with dip net for experimentation.

Fig. 4 - Adult smelt being captured with short-handled dip net when major run is in river.

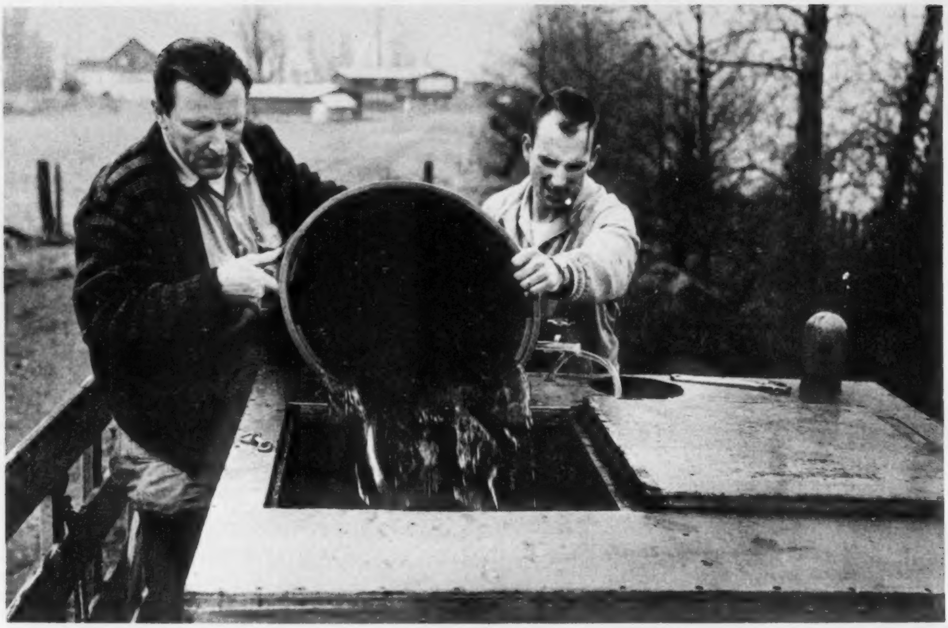


Fig. 5 - Transferring smelt from Cowlitz River to transportation tank; oxygen is provided to insure maximum survival.

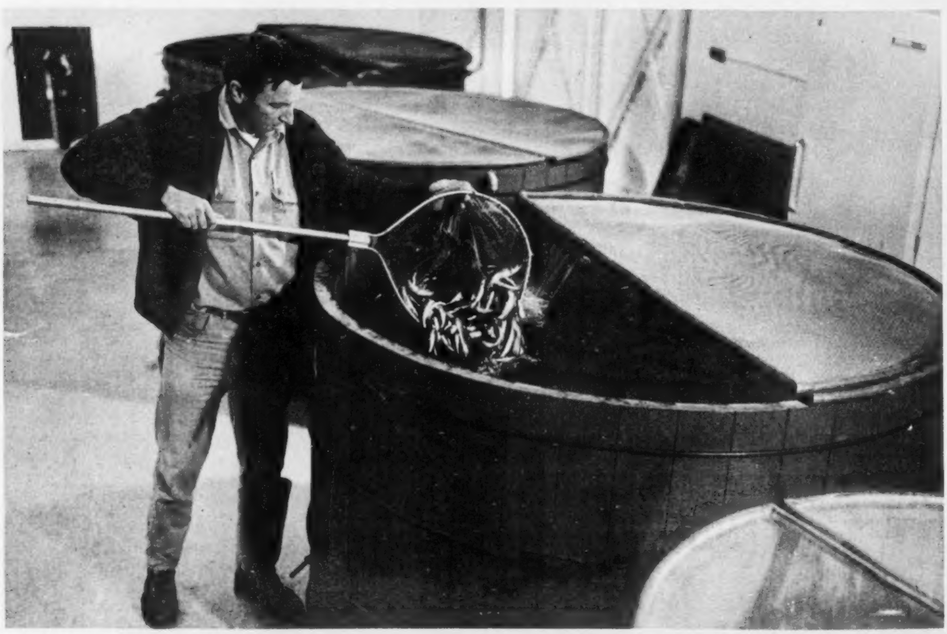


Fig. 6 - Placing smelt in holding tanks on floating lab for several days before testing.

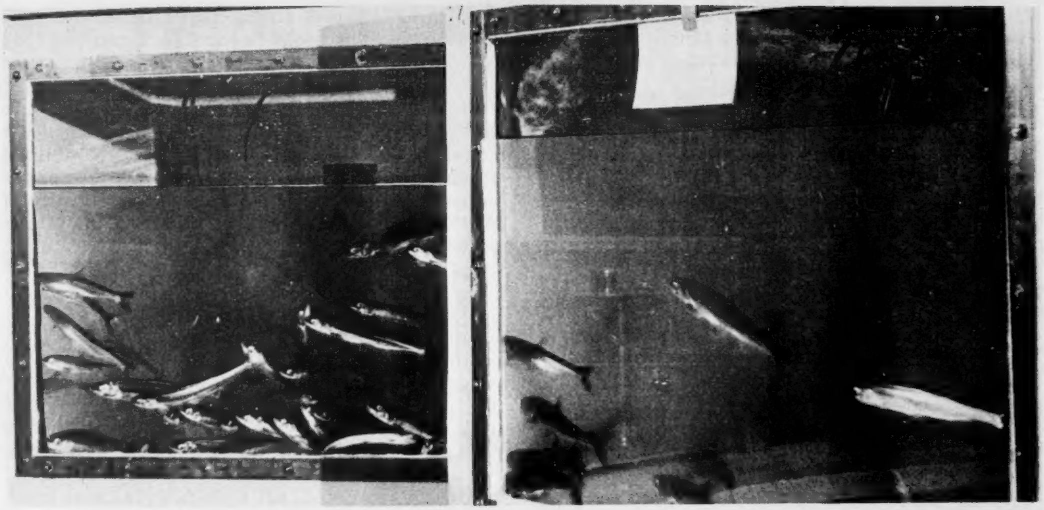


Fig. 7 - Adult smelt subjected to increases in water temperature in 50-gallon test tanks. Each tank contains similar number of fish; the water in tank on right was 1° C. warmer than in tank on left.

Fig. 8 - Biological technician checks tanks periodically to assess effects of increasing temperatures on smelt.

are intolerant to temperature increases. The first fish were taken from mainstem of Columbia River by commercial fishermen cooperating with Washington Department of Fisheries.

More fish were obtained from Cowlitz River by laboratory staff. Fish were dip netted from a boat and on the beach. They were transported by tank trucks to Prescott and placed in tanks aboard floating lab. (They were first transferred to holding tanks to determine handling mortalities and placed in test tanks with heated water.)

Temperature-Tolerance Studies

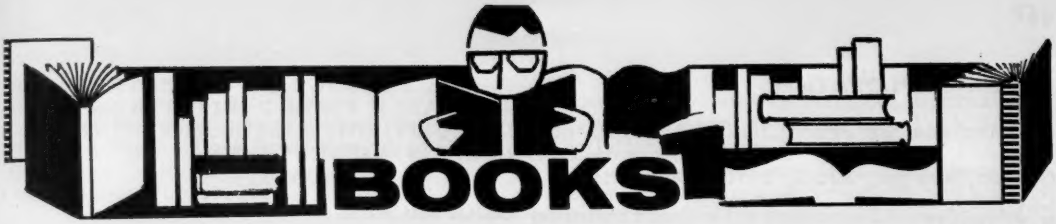
The general results of temperature tolerance studies verified earlier results: adult smelt are sensitive to temperature increases. Increases of 10° F. killed all test fish in 8 days. Temperature increases of 5° F. killed 50% in same time period. Higher temperatures killed fish in shorter period. Studies of smelt eggs showed these more resistant to temperature increases than the adults. Again in 1969, adult fish were reluctant to deposit eggs after subjection to increased temperatures.

Smelt populations could face serious problems if thermal nuclear plants are allowed to discharge heated water into river. The problems could be compounded if water-temperature regulations and standards for Columbia are based on tolerance limits of steelhead trout and salmon, the most valuable anadromous fish. The most favorable temperatures for salmon and trout range from 42 to about 60° F. The thermal electric power industry states that more heat could be allowed into Columbia during winter; also, that this increase, theoretically, could benefit salmon production during near-freezing temperatures. However, our present knowledge of thermal tolerance levels for smelt indicates some temperature increases could be detrimental.

Water-temperature standards for the Columbia River--recommended by Washington State--allows addition of more heat into the river at lower temperatures than during summer. Oregon standards for Columbia allow only increases of 2° F. at any time, not to exceed 68° F. Water-temperature standards for interstate waters should be consistent and designed to protect all commercial and sport fish.

Industrialization & Smelt's Fate

Many experts predicted that severe winter temperatures during December and January, 1968-1969, would keep smelt from entering Cowlitz River to spawn. The smelt did enter the river--but they were 5 weeks late. If colder water produces erratic and nonpredictable smelt runs, would warmer water produce similar situation? The fate of smelt runs in lower Columbia River may be determined by increasing industrialization.



CARIBBEAN-ADJACENT REGIONS BIBLIOGRAPHY AVAILABLE

As part of its contribution to Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR) the National Oceanographic Data Center sponsored preparation of Volume I of CICAR Bibliography on Meteorology, Climatology, and Physical Chemical Oceanography. This volume contains more than 3,000 references (2,000 with abstracts) on these subjects in Caribbean Sea, Gulf of Mexico, Greater and Lesser Antilles Regions, and adjacent coastal areas of North Central and South America. Subject, geographical, and author indexes are included.

How Much & Where

Volume I was prepared by American Meteorological Society from their files in Meteorological and Geoastraphysical Abstracts Office, and from Government library files in Washington, D.C., area.

The Bibliography costs $7; the indexes to Bibliography are $6 a copy; the complete set is $13. Write to: National Oceanographic Data Center, Department of Commerce, NOAA, EDS, Rockville, Md. 20852.

OCEANOGRAPHY

"Marine Atlas of the Pacific Coastal Waters of South America," by Merritt R. Stevenson, Oscar Gullén G., and José Santoro de Ycaza, 20 p. and 99 charts, $40. University of California Press, 2223 Fulton St., Berkeley, Calif. 94720.

The atlas resulted from a $2\frac{1}{2}$-year international cooperative study "to determine seasonal variations of selected properties and of surface circulation in the Pacific coastal waters of South America." The data were gathered quarterly by scientists from Colombia, Ecuador, Peru, Chile, and the Inter-American Tropical Tuna Commission (IATTC).

During field operations, IATTC was data-clearing center for participants and helped process data by computer.

The investigation was begun "to learn more about the occurrence of the El Niño (The Child) condition. . . . El Niño occurs irregularly; it may appear 2 years in succession and then may not appear for a number of years."

INTERNATIONAL LAW

"International Law and the Resources of the Sea," by Juraj Andrassy, 191 p., maps, $7.50. Columbia University Press, 440 West 110th St., New York, N. Y. 10025.

The legal status of the ocean bed transcends legal interest. It could affect world's economic balance and structure of international relations. The basic issue is between preserving at least the most important aspects of freedom of the seas--and the taking of the ocean bed by nations and its exploitation by competing economic interests. This would diminish freedom of navigation and fisheries, and multiply dangers of polluting the oceans.

The book has 3 parts: The first deals with the natural and technological factors that caused the current problems. The second is concerned principally with "the evolution of the continental shelf as a legal concept." The last discusses legal solutions.

MARINE EXPLORATIONS

"Man and the Sea: Classic Accounts of Marine Explorations," edited by Bernard L. Gordon, 498 pp., $9.95, 1970. Doubleday & Company, Inc., 277 Park Avenue, New York, N.Y. 10017.

"This book has been prepared to give students of marine science historical and contemporary insights into the growth and development of oceanography," Prof. Gordon writes.

He has selected the writings of marine explorers through history: from the past, such men as Franklin, Halley, and Agassiz; from the present, accounts of such explorers as Cousteau, Piccard, and Carpenter.

The book contains 71 selections, starting with "The Flood" in the Book of Genesis and reaching to "The Promise of Seaweed," written in 1969.

SMALL-CRAFT NAUTICAL CHARTS COMPLETE COVERAGE OF TEXAS COAST

Commerce Department's National Oceanic and Atmospheric Administration (NOAA) has announced completion of small-craft nautical-chart coverage of the entire 334-mile Texas coast from Galveston to Brownsville with publication of two new charts--892-SC and 893-SC. The charts are being issued by NOAA's National Ocean Survey (formerly Coast and Geodetic Survey and U.S. Lake Survey).

What They Cover

Small-craft Chart 892-SC covers the Texas Intracoastal Waterway from Carlos Bay to Redfish Bay. It includes for first time coverage of Copano Bay. Chart 893-SC covers the Waterway from Redfish Bay to Middle Ground. It includes for first time coverage of entire Baffin Bay area.

Where to Get Them

The new charts cancel Conventional Charts 892 and 893. They can be purchased for $1.50 each from National Ocean Survey chart agents, or from National Ocean Survey, Distribution Division (C-44), Washington, D.C. 20235.

THE FOLLOWING PUBLICATIONS ARE AVAILABLE FROM PUBLICATIONS SERVICES UNIT, NMFS, 1801 N. MOORE ST., ARLINGTON, VIRGINIA 22209:

LAKE MICHIGAN

"Physical and Ecological Effects of Waste Heat on Lake Michigan," 101 p. Prepared by Great Lakes Fishery Laboratory, NMFS, Ann Arbor, Michigan, in cooperation with Bureau of Sport Fisheries and Wildlife and Federal Water Quality Administration. Fish and Wildlife Service, Sept. 1970.

"There is reason for concern about potential serious ecological damage to Lake Michigan as a result of the discharge of industrial and municipal waste heat," the report states. By year 2000, the waste heat load at predicted rate of increase would be 10 times today's load. The power industry would be responsible for most of it. There is no sign that the rate of increase in required power capacity, which has been doubling each decade, will diminish.

Not enough is known about ecological effects of "massive heated effluents." The information needed now is not available, so interim standards must be set for Lake Michigan based on present knowledge.

"The purpose of the present report is to present the available evidence that substantiates this concern. The evidence reasonably demonstrates that heat addition, as presently proposed, is an essentially cumulative problem that would contribute to inshore eutrophication and be intolerable from the fish and wildlife standpoint by year 2000."

It is in public interest to stop this process now. The Department of the Interior supports stringent standards for Lake Michigan. It believes no "significant amounts" of waste heat should be discharged into the lake.

NEW YORK BIGHT

"Evaluation of Influence of Dumping in the New York Bight with A Brief Review of General Ocean Pollution Problems," 65 p., plus 3 appendices, June 1970.

In Feb. 1970, Interior Department appointed an Ad Hoc Committee "to review the practice of ocean disposal in the New York Bight and to make appropriate recommendations." Committee chairman was Dr. Roland F. Smith, Assistant Director for Marine Resources, National Marine Fisheries Service.

The Committee's findings, verbatim, were:

1. The New York Harbor Complex must rank as one of the largest grossly polluted areas in the United States.

2. The major sources of pollution in the New York Bight . . . are (1) sewer and industrial outfalls, (2) ocean disposal of sewage sludge and dredge spoil, (3) river discharge and land runoff, (4) wastes from vessels, (5) accidental spills, and (6) harbor debris.

3. No significant improvement in the water quality in the New York Bight can be expected until the mid-70's. Complete secondary treatment is not scheduled for New York City and Passaic Valley Sanitation Commission until 1976. Additional pollution treatment facilities in up-river and shoreline communities will not be completed until the mid-70's. Vessel pollution should be significantly reduced under the provisions of the Water Quality Improvement Act of 1970.

4. Even with completion of all currently proposed pollution abatement programs, conditions in the New York Bight will fall short of what must be the ultimate goal of protecting coastal ocean environments from serious degradation.

5. There will be increased pressure for more ocean disposal of sewage sludge and dredge materials in the New York Bight. This will raise to a potentially critical level the threat of pollution to land and surrounding ocean.

6. The projected increase in pollution from ocean disposal practices calls for stricter control of future ocean disposal practices in the New York Bight.

7. The major threat to full enjoyment of the proposed Gateway National Recreation Area and other beaches in the New York Bight is pollution. To date, however, there has not been demonstrated any connection between present ocean dumping practices and water pollution at any of the proposed Gateway sites.

8. The present ocean disposal of sewage sludge and dredge fill may be a serious threat to the sanitary quality of local populations of ocean quahogs and surf clams (4-10 mile radius).

9. Accumulation by fish and shellfish of heavy metals and other persistent toxic compounds is another potential health hazard in the New York Bight. This threat appears to be most serious from the sludge disposal areas.

10. Ocean disposal of sludge and dredge spoil materials, along with pollution from other sources, offer a potential threat to local fish populations.

11. There is a need for one agency to accumulate all pertinent water pollution data in the New York Bight.

12. The fundamental problems associated with pollution abatement and control are institutional--economic, legal, social, etc. The fact of the matter is that technology is available for cleaning up the New York Bight.

13. Known alternatives to present ocean disposal practices will cost substantially more. Further studies are needed to detail more clearly the relative advantages, operational costs, and potential environmental problems of each alternative. Substantial alterations in consumer habits and existing institutions also will be required.

Ocean Pollution

1. Ocean pollution is the unfavorable alteration of the marine environment, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution, and distribution, abundance, and quality of organisms. These changes may affect man directly or indirectly through his supplies of food and other products, his physical objects or possessions, and his opportunities for recreation and appreciation of nature.

2. The problem of ocean pollution is part of the total problem of waste disposal with all its social, political, economic, and legal constraints. Any workable solution to controlling ocean pollution must consider the total problem.

3. Controlled ocean disposal of wastes is a legitimate use of the sea. However, the effects of various types of ocean disposal must be carefully considered.

4. The high seas have a limited capacity to assimilate certain biologically active waste products; coastal areas have a limited capacity to receive any waste material.

5. The ultimate goal of disposal programs must be to allow into the ocean only that which can contribute to improving the ocean environment, that which is essentially inert, or that which can be assimilated without adverse effects.

6. The disposal of all types of wastes into the ocean is projected to increase substantially in this decade unless adequate controls are initiated.

7. Unless reversed, this trend portends serious health hazards and threatens fishery resources and the marine environment in a number of localities. Unfortunately, the extent and magnitude of these dangers are not well understood nor adequately documented.

8. The extent of specific Federal authority to enforce waste disposal regulations and ocean pollution beyond the territorial sea (generally 3 miles) needs to be clarified.

9. At present, no Federal agency has authority to develop water quality standards beyond the territorial sea.

10. Action by regional, State, and local governmental bodies to control ocean disposal of wastes is not generally adequate, stressing the need for more appropriate support and guidelines at the Federal level.

11. Present and projected demands upon our natural resources call for substantial emphasis on ways of reusing, recycling, and reclaiming materials which are now considered waste. Legislation to encourage this is needed.

12. Without proper consideration of legal, economic, and other institutional constraints, pollution and deterioration of coastal waters and even the high seas can be expected to increase.

14. Aside from physical and aesthetic aspects of pollution, most other major deleterious effects are toxicological. These present an array of complex environmental problems affecting man and marine organisms and operating essentially at the cellular level.

14. Opportunities for interagency cooperative programs are not being exploited adequately. Substantial data and expertise existing in any given agency are, for a variety of reasons, not always used by another agency.

15. Research by Federal agencies on problems of ocean disposal and ocean pollution is not generally duplicative; on the contrary, there are many areas which are not receiving enough attention, or are receiving no attention at all. They include:

a. Detailed knowledge of coastal circulation and ecology

b. Understanding of economic and social aspects of ocean pollution

c. Ecological and oceanographic data bases

d. Inventory of what is being, and what has been, dumped and their effects

e. A knowledge of extractable materials in the wastes that can benefit fish and shellfish production

f. The fate of pathogenic organisms in marine waters

16. The Committee developed interim guidelines for the Corps of Engineers.

Recommendations

The Committee states that "recommendations do not solve problems"--but recommendations "can serve as a starting point for planning and organization" by government agencies concerned. The Committee recommended policies and activities that would make significant contributions toward abating the problems.

INTERNATIONAL

FAO COMMISSION URGES PROTECTION OF INDIAN OCEAN TUNAS

International action to prevent depletion of large tunas in the Indian Ocean was recommended in Oct. 1970 by UN commission meeting in Rome. The commission recommended development of the Ocean's vast fishery resources by scientific planning and cooperation.

The 28-nation group urged that "serious consideration" be given international measures to manage heavily exploited large-tuna species caught by longline.

The commission recommended that its 8-nation tuna committee be reconvened promptly with participation of all nations that fish tuna actively in the Indian Ocean.

Shrimp in Iran-Arabian Gulf

The commission also warned of the "urgent need" to manage the shrimp fisheries in the gulf between Iran and Arabian peninsula. Because these fisheries lie in waters under national jurisdiction, FAO was asked to notify the governments concerned and to promote international action. A group will assess shrimp stocks in the gulf and elsewhere in the Indian Ocean.

Indian Ocean Commission

The Indian Ocean Fishery Commission is one of 6 FAO regional fishery bodies. It was established in 1967 to develop fishery resources to help meet increasing world demands for rich protein food.

The Indian Ocean covers almost one-fifth the earth's marine area. In 1968, it yielded 2,400,000 metric tons of fish of the world catch of 64,000,000 tons. Roy I. Jackson, FAO Assistant Director-General for Fisheries, has said the Indian Ocean's annual yield might be increased five times.

FAO operates many field projects in the Indian Ocean region under the UN Development Programme and the Freedom-from-Hunger Campaign. These include preinvestment surveys of fishing harbors in India and fishery surveys in Somalia.

FIAT PANIS

A Korean child enjoys seafood méal. (FAO)

FAO STUDIES DISTRIBUTION OF PROTEIN-RICH FOODS

Methods of promoting distribution of new, protein-rich baby foods to millions of malnourished children were studied in Rome in Nov. 1970 by the Protein Advisory Group of FAO, UNICEF, & the World Health Organization. The group discussed current and future marketing operations for these foods in more than 10 countries and ways to expand their use in other parts of the world. A major obstacle is family resistance to unfamiliar foods.

Launching new foods is complex problem. The operation must consider local preferences and habits. Market and consumer research is necessary to collect information needed to establish new products.

Current Emphasis on Children

The current FAO study emphasizes provision of protein-rich foods for children because of grave effects of protein deficiency on mental and physical growth. However, the complete program seeks also to close the "protein gap" for millions of adults.

Unless major new sources of protein are developed, it is estimated that, by 1985, the shortage of protein in developing countries will amount to 3.6 million tons annually. This is equal to amount now consumed by the 6 Common Market countries.

'Superamine'

A successful program has been operational in Algeria since 1966. There, a protein-rich infant food, 'Superamine', was developed and marketed.

Superamine is a low-cost protein formula based on local raw materials: hard wheat, 28%, chick pea, 38%, and lentil flour, 19%. The formula is processed to form a precooked mixture to which are added dried skimmed milk, 10%, sugar, 5%, vitamins, calcium, and vanilla flavoring.

N.A. Wilkie, FAO Food Promotion Officer, has reported: "According to the National 4-year Plan, Algeria will be producing 8,000 tons a year of Superamine by 1974.

"The Algerian government's confidence in the results of this program can be measured by its investment plans. Government funds have been allocated to finance 3 additional production plants in the period 1971/74. Its objective is to meet the annual dietary needs of between 200,000 and 300,000 infants, approximately all those suffering from acute or mild conditions of protein deficiency. It is an ambitious and challenging plan."

Nations Interested

Algeria already has shipped Superamine to help Nigeria, the United Arab Republic, and Tunisia. Recent test marketing of Superamine in the UAR showed that ready commercial market could be created for 1,000 tons a year, even without subsidized distribution. The UN is working with governments in North Africa, the Near East, and other regions to develop and market their own protein-rich infant food.

Similar projects are operational in Turkey, UAR and Yugoslavia. Tunisia, Cuba, Iran, Morocco, and Madagascar also are interested.

OIL POLLUTION HARMS MARINE LIFE, FAO CONFERENCE TOLD

Up to 10,000,000 tons of oil are spilled each year into the oceans. The oil has a toxic effect on all marine animals--and there is no effective method to neutralize it. The only way to prevent more pollution and preserve the ocean's protein-rich food is to prevent spillages. This was the theme of a paper presented by Max Blumer, Woods Hole Oceanographic Institute, Mass., to FAO's Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing, in Rome, Dec. 9-18, 1970.

The conference attracted hundreds of marine biologists, oceanographers, and pollution experts from many nations to discuss the scientific basis and to recommend remedial action.

A prospectus prepared for conference warned that pollution is a spreading international problem, and that it is time for necessary countermeasures.

Oil is $\frac{3}{4}$ Pollution Incidents

Blumer estimated that oil pollution involves one to ten million metric tons of crude oil and oil products a year. In the U.S. alone, oil accounts for three-fourths of about 10,000 pollution incidents reported annually.

Countermeasures are effective "only if all the oil is recovered immediately after the spill," he said. However, no existing technology can do it. All proposals to clean away oil, such as dispersing it or sinking it, are inefficient because the oil continues to poison the marine environment in one form or another. Detergents and dispersants, supposedly nontoxic, are harmful to environment. This was shown in aftermath of Torrey Canyon disaster.

Oil Harms All Marine Organisms

Blumer challenged claims that oil pollution is not necessarily harmful to all marine organisms:

"All crude oils are poisons for all marine organisms. Many crude oil distillates are more severely poisonous because they contain higher proportions of the immediately toxic compounds. Long-term toxicity may harm marine life that is not immediately killed by spills, and oil can be incorporated into the meat of marine animals, making it unfit for human consumption. Crude oil and oil products may cause cancer in marine organisms. Even at very low concentrations oil may interfere with processes which are vital for the propagation of marine species."

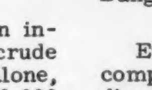
He added that the most toxic oil compounds are water soluble. This makes recovery of oil slicks futile, except for esthetic improvement. "Treatment with detergents, even the 'nontoxic' ones, is dangerous because it exposes marine organisms to higher concentrations of soluble and toxic hydrocarbons and because it disperses oil into droplets that can be ingested and retained by many organisms."

Danger to Whole Ocean

Eventually, natural bacterial action decomposes spilled oil. But the most toxic oils disappear much more slowly than less harmful ones. The possibility exists that products of bacterial oil degradation may be more toxic than oil itself.

Blumer denied that marine animals will naturally avoid oil spills. Lobsters, for example, are attracted to crude oil distillates. This leads to severe contamination or death. It was also "highly improbable" that "tainted" fish and shellfish become edible again in time.

Blumer noted the damage done to Lake Erie and warned it could happen to the ocean over a longer period. "A polluted small lake can be reclaimed within a few years. Lake Erie may or may not be restored within fifty years, but a polluted ocean will remain irreversibly damaged for many generations."



EUROPE

NORWAY

CAPELIN FISHERY LOOKS GOOD AT LEAST UNTIL 1973

The Norwegian capelin fishery looks favorable until at least 1973, unless the greatly increased catch overtaxes the resource. The 1970 catch exceeded 1,300,000 metric tons, about double 1969, and a record. Capelin became the main source of supply for fish meal when herring began to decline in 1968.

Problem Ahead

Recent investigations of the capelin resource indicate the 1970 recruitment was somewhat poorer than expected. The fishery seems to develop into an all-year operation with more units participating. So research scientists say it is questionable whether the stock can withstand continuous fishing. According to T. Monstad, there is danger of overexploitation and a shift in natural foundation if two or more years indicate continuous poor survival.

Questions Remain

Despite studies in recent years there are insufficient data to ascertain whether regulation should be started. It has been established that capelin grow during summer up to Oct.-Nov. Researchers feel that there should be no fishing during growth period to maintain foundation of stock. It is questionable whether minimum mesh size would maintain stock.

Optimism until 1973

Most recent investigations in the Barents Sea show evidence of capelin from 1967, 1968, and 1969 year-classes. The 1967 year-class was unusually good and is expected to spawn in 1971. Good year-classes also were found during 1968 and 1969. This indicates possibility of a useful capelin fishery at least until 1973. (Reg. Fish. Attaché, U.S. Embassy, Copenhagen, Oct. 27, 1970.)

USSR

SOVIETS TRAIN WOMEN AQUANAUTS

Three women aquanauts are being trained for marine research in the Chernomor Underwater Laboratory on the Black Sea. The first part of their training included pressure-chamber work at depths of 12, 30, 60, and 100 meters. After they complete a course in aqualung diving, they will be ready to join the Chernomor team. ('Moscow News', Oct. 13, 1970.)

Tektite II Girls First

[Ed. Note: The Soviets are claiming a "first": "until now there have been no women aquanauts either in the Soviet Union or abroad." Actually, in summer 1970, 4 U.S. women scientists participated in "Tektite II" in the Virgin Islands.]

* * *

SOVIETS BEGIN ANTARCTIC WHALING SEASON

Three Soviet whaling factoryships have sailed for Antarctica: 'Sovetskaia Ukraina,' Oct. 7, from Odessa; 'Iurii Dolgorukii', Oct. 11, from Leningrad; and 'Sovetskaia Rossiia', Oct. 15, from Vladivostok. These fleets participated in 1969 Antarctic season.

It is the 25th trip for the Sovetskaia Ukraina.

ASIA

JAPAN

TUNA ASSOC. PROPOSES REGULATING S. BLUEFIN TUNA FISHERY

The Federation of Japan Tuna Fishery Cooperative Associations (NIKKATSUREN) has proposed a preliminary plan to regulate the Japanese southern bluefin tuna fishery. Its purpose is to set up voluntary restrictions on longline fishing to protect declining resource.

Areas To Be Affected

The proposal would restrict entry of Japanese vessels in these areas during specified periods: (1) Great Australian Bight--Oct. to Mar.; (2) off Sydney--Mar. to July; (3) off South Africa--Oct. to Mar.; and (4) west of Australia in "Okiku" ground--Dec. to Mar. The "Okiku" grounds are bluefin spawning area.

The waters off Sydney are migrating route for young bluefin. The other two areas are where percentage of small fish in catch markedly increases seasonally. At present, about 250 Japanese longliners are fishing areas to be restricted.

What NIKKATSUREN Foresees

The Japanese longline catch of southern bluefin off Australia and South Africa has decreased in recent years: from record 70,000 metric tons in 1960 to 44,000 tons in 1968. This indicates bluefin resource is in danger without controls.

If its proposal is implemented, NIKKATSUREN explained, the average age of southern bluefin taken will increase from present 6 years to 6.5 years; as a result, the fish would be larger.

While total catch during first year of the regulatory program would decrease, the previous catch level (as in 1960) would be restored and surpassed after several years. Also, the spawning rate would increase by 20%; at present, it is estimated to be less than one-tenth of that under natural conditions (when there is no fishing). ('Minato Shimbun', Oct. 16, 1970.)

* * *

OCEAN DEVELOPMENT CENTER PLANNED

The Japanese plan to build a semi-governmental development center on a 66,000-sq.-meter plot at Oppama, Yokosuka, Kanagawa Prefecture. Patterned on a French center, it will be the first in Japan.

The Center's Facilities

The center will have sea labs (completed by spring 1971) a deep-sea diving simulator, diving training pool, water tanks, and multi-purpose labs with a staff of 229.

Also, a 4-man undersea habitat will be built at 100 meters in Sagami Bay near Yokosuka.

Private industry, universities, and government agencies will be allowed to use center for research in oceanography, ocean engineering, diving, geology, and fishery studies.

The center will serve as base port for the 'Shinkai', a deep-sea research vessel owned by STA.

How Financed

The center will be financed by KEIDANREN (Federation of Economic Organizations) and Science and Technology Agency (STA). The first 5-year program will begin in fiscal year 1971 (starts Apr. 1971) and cost 6,500 million yen (US$18,055,000). Projects for first year are expected to cost KEIDANREN 2,000 million yen ($5,555,555) and government (STA) 150 million yen ($416,666). The government will send necessary bill to the Diet. ('Japan Times', Sept. 29, 1970.)

* * *

NEW PRESERVATIVE FOR MEAT & FISH DEVELOPED

A synthetic liquid preservative has been developed in Gumma Prefecture. When sprayed on meat or fish, it will keep them fresh 4 to 5 times longer than an untreated product.

The major ingredients are pyroligneous acid (charcoal byproduct), lactic acid, sodium chloride, and lemon essence. It is said the

JAPAN (Contd.):

new preservative is free from such poisonous substances as formalin and methyl alcohol.

Useful in Major Items

A recent test proved that meat sprayed with new preservative remained fresh for 4 days; unsprayed meat spoiled after only 1 day. The preservative is supposed to be especially useful for meats and chicken, which are highly perishable. Fish and shellfish also can be treated effectively.

One liter of the preservative (enough to treat 1,000 chickens) costs 400-500 yen ($1.11-1.39). Patent rights are being applied for. ('Mainichi Shimbun', Oct. 10, 1970.)

* * *

SCIENTISTS OBTAIN LIQUID PROTEIN FROM KRILL

Japanese scientists have succeeded in producing liquid protein from euphausia, a shrimp only 3 to 4 centimeters long caught by Kyokuyo Hogei Co. during past Antarctic whaling season. The work was done in the Tokai Regional Fisheries Research Laboratory of the Japanese Fisheries Agency on an FY 1970 budget of 400,000 yen ($1,111).

The laboratory researchers believe that this liquid protein, when commercially produced, can be used in manufacture of soup flavors, pet foods, and snack foods. The shells will be used to produce feed.

Heated With Enzymes

When Antarctic euphausia is heated with enzymes at 20°-30° C. for 4-5 hours, it is reduced to a mash (42% water, 42% protein, 0.1% fat, 7.2% ash, and 8.7% sugar).

The laboratory plans to begin commercial production in 1971. If successful, it will go on to study products from mackerel and jack mackerel. ('Shin Suisan Sokuho')

* * *

BRISTOL BAY CRAB FLEETS REACH QUOTA

The 2 Japanese crab fleets accompanied by factoryships 'Keiko Maru' (7,536 gross tons) and 'Koyo Maru' (7,658 gross tons) attained their goals by late Sept. 1970: tanner crab catch quota and combined production goal of 85,000 cases ($\frac{1}{2}$-lb. 48s) of king crab. The fleets had been operating in Bristol Bay crab fishery since March.

Keiko Maru returned home on Sept. 26, and Koyo Maru on Oct. 8.

Commander's Evaluation

The Koyo Maru fleet commander said condition of king-crab resource has not changed much and present catch allocation is good. He noted that the size of king and tanner crabs in 1970 was same as in 1969--but somewhat smaller than 7 or 8 years ago.

The king-crab catch rate per "tan" in 1970 by Koyo Maru fleet was slightly higher than 1969 average of 6.9 crabs. ('Suisan Keizai Shimbun', Oct. 19, 1970.)

* * *

JAPANESE TRAWL FISHING IN NORTHWEST ATLANTIC

In mid-Oct. 1970, four Japanese stern factory trawlers (2,500-gross-ton class) were fishing in northwest Atlantic area of International Convention for the Northwest Atlantic Fisheries (ICNAF). These were: 'Zao Maru' (2,530 gross tons), 'Shirane Maru' (2,528 GT), 'Tokachi Maru' (2,501 GT), and 'Suzuka Maru' (2,500 GT), all owned by Nihon Suisan. These trawlers were dispersed over wide area to conduct detailed groundfish survey.

Fishing Egg-Bearing Herring

But in Oct., fishing was concentrated on egg-bearing herring; ocean perch and argentines also were caught. Fishing in 1969 showed egg-bearing herring abundant in ICNAF area during October-early November.

Squid Fishing in December

From December 1970, when squid fishing begins to pick up, stern trawlers will start concentrating on squid. These vessels are likely to be joined by about 10 other trawlers from squid and octopus fisheries off Spanish Sahara and Mauritania. Thus, as in 1969, about 14-15 Japanese trawlers are likely to fish in ICNAF area during coming squid season. ('Suisan Tsushin', Oct. 12, 1970.)

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JAPAN (Contd.):

SKIPJACK-TUNA FISHING IS GOOD IN SOUTHWEST PACIFIC

A Japanese-Australian joint company (Gollin Kyokuyo), exploring pole-and-line skipjack fishing off New Ireland (east of New Guinea), reports good fishing. Seven 40-gross-ton wooden vessels are active. Catch per vessel averages 5 metric tons a day. Most landings were frozen and shipped to Japan, where they sold for 120 yen a kilogram (US$302 a short ton).

Commercial Fishing Feasible

Survey off New Guinea began in Mar. 1970. It has found skipjack and baitfish abundant. Indications are that the area definitely can support full-scale commercial fishing.

A company official explained that he would like the line-and-pole operations mechanized, and the wooden vessels replaced with steel or fiberglass hulls (because of heavy infestation of wood borers). ('Suisan Keizai Shimbun', Oct. 13, 1970.)

* * *

PURSE SEINERS EXPLORE FOR TUNA IN SOUTHWEST PACIFIC

Two Government-subsidized purse seiners are exploring for tuna in the southwestern Pacific. The 'Taikei Maru No. 23' (210 gross tons) departed Japan Oct. 15, the 'Tokiwa Maru No. 58' (357 gross tons) Nov. 17, 1970.

The vessels are surveying two areas: (1) off Palau; and (2) off northern New Guinea. ('Minato Shimbun', Sept. 27, 1970.)

* * *

FISH SPINY LOBSTER OFF MOZAMBIQUE

In September 1970, a Nichiro Fishing Co. vessel landed 20 metric tons of spiny lobsters caught off Mozambique (southeast Africa). The average weight was 200 grams. Nichiro expects to find a good market in Japan. If sales are successful, lobster fishing may be expanded.

Nichiro estimates that a year of exploratory fishing is required before commercial fishing can be started.

Local Fishermen Use Pots

The lobster grounds are outside Mozambique's 12-mile fishery zone. Local fishermen are fishing lobsters with pots. More Japanese trawlers could arouse their protests.

Nichiro Experience

Several years ago, another Nichiro trawler took about 10 tons of lobsters in the same area. The lobsters were quick frozen and sold in Japan at US$0.88-1.01 per lb. This year (1970), Nichiro is boiling, freezing, and packing the lobsters and expects to sell them at $1.26-1.51 per lb.

The good catch has stimulated interest in other companies, which are watching Nichiro's sales. ('Minato Shimbun')

* * *

BUILDS THIRD 5,000-GROSS-TON TRAWLER

The 5,000-gross-ton stern trawler 'Ohtori Maru' was scheduled to be launched Oct. 30, 1970, at the Maizuru Heavy Industries shipyard. The vessel was ordered by Ohtori Suisan Co., established jointly by Kyokuyo Hogei and Tokunaga Kabushiki Kaisha companies. It will be the third 5,000-ton trawler to be built in Japan. The other 2 are 'Yamato Maru' (Nihon Suisan Co.) and 'Rikuzen Maru' (Hokoku Suisan Co.).

Production Capacity

Ohtori Maru will be equipped with quick-freezing capacity of 70 metric tons; "surimi" (minced meat) production capacity of 40 tons a day; and a meal plant capable of processing daily 125 tons of fish. After completion in late Feb. 1971, the vessel will be sent to Bering Sea.

Its Dimensions

Main specifications: overall length 105 meters (344.4 feet); width 17.6 meters (57.7 feet); depth 11 meters (36.1 feet); and main engine 5,900 hp. ('Nihon Suisan Shimbun', Oct. 14, 1970.)

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JAPAN (Contd.):

EXPORTS USED FISHING VESSELS

The Japanese exported 54 used fishing vessels (including 23 tuna longliners) during April-Sept. 1970.

Of the 54, 24 (14 tuna longliners) went to S. Korea; 10 (6 trawlers, mostly shrimp) to Indonesia; 9 to Panama; 5 to the Philippines; and 6 to other countries.

S. Korea Receives Many

Exports to S. Korea included a 200-gross-ton refrigerated carrier and vessel parts for two 120-ton trawlers, three 100-ton trawlers, and over 600 small coastal fishing craft. The vessels were supplied in accordance with the fishery cooperation fund provided by Japan. ('Suisancho Nippo', Oct. 16, 1970.)

* * *

SUCCESSFULLY RECRUIT U.S. TUNA FISHERMEN

Susumu Sugano, president of the Japan Overseas Purse Seine Fishing Co., reportedly signed 7 U.S. tuna fishermen during a recent trip to San Diego. They will serve aboard 1,000-gross-ton Japanese purse seiner now being built in Japan. It's a 1-year contract beginning in Feb. 1971.

The 7

The 7 men are a fishing captain, deck boatswain, winch man, seine skiff operator, two speedboat operators, and a net man. They are scheduled to visit Japan twice during construction of the seiner to give technical advice. The ship's master and the chief engineer will be Japanese.

Plan for Vessel

The vessel is scheduled to be completed late Feb. 1971. It will fish in eastern Pacific yellowfin tuna regulatory area during open season. Then it will proceed to Atlantic fishing grounds. ('Suisan Keizai Shimbun', Oct. 15, 1970.)

* * *

FROZEN ALBACORE TUNA EXPORT PRICE TO U.S. HITS HIGH

In mid-Oct. 1970, the price for Japanese frozen round albacore exports to the U.S. reached a high of c. & f. US$800 a short ton for delivery to California tuna packers. This is an increase of $250 a ton in $1\frac{1}{2}$ years.

U.S. Demand Rises

The price increase is attributed to rising U.S. demand for albacore. It has put that species in short supply because annual world catch for years has been around 200,000 metric tons. ('Suisan Tsushin', Oct. 14, 1970.)

* * *

FISH FLOUNDER OFF WESTERN KAMCHATKA & IN BERING SEA

In 1968, a decline in flounder stocks off west Kamchatka forced 3 Japanese firms (Hokoku Suisan, Hoko Suisan, Hakodate Kokai Gyogyo) to suspend fishing. In 1969, only the 'Nojima Maru' fleet of Hokoku Suisan again fished flounder off western Kamchatka. Fishing was "reasonably good" because the flounder resource had recovered. Processing part of the catch into fillets resulted in a financial gain that was "better than keeping the mothership at dock."

Vessel Lengthened

To use the 'Kashima Maru' (about 7,000 gross tons), now a reefer, as a full-time mothership for year-round flounder fishing in Bering Sea, Nippon Suisan lengthened vessel by 10 meters in fall 1970. It replaced existing meal plant with a larger one to use more efficiently the waste from filleting.

The Kashima Maru fished during 3 winter seasons. In winter 1967/1968, for first time, it suffered a large deficit from fishing in Gulf of Alaska. Fishing the Bering Sea, however, for the 2 winter seasons 1968/1969 and 1969/1970 was better. The market for flounders processed in Bering Sea (Nov. to Mar.) was especially good. Nippon Suisan is confident that year-round fishing in Bering Sea will prove profitable. ('Minato Shimbun')

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The cod bag breaks surface several yards from trawler, while hungry Royal Albatrosses and Yellow-browed Mollymawks cluster round and try vainly to take fish through mesh. (Royal Albatross extreme left and distant right.)

Sea birds are constant companions, day and night, of the trawler. Albatrosses may travel as much as 600 miles back to their young on the Campbell or Southern Islands of New Zealand with food. (FAO)

SOUTH PACIFIC

AUSTRALIA

REPORT ON FISHING VESSELS & PEOPLE

In 1968-69, there were 9,244 vessels and 16,460 persons in Australia's general fisheries. Value of vessels and equipment was US$70,418,000. The data are incomplete because fishing is seasonal and many fishermen are part-timers.

Number & Value of Vessels

The highest number of vessels was registered in South Australia--2,591; then, New South Wales, 2,345; Western Australia, 1,412; Queensland, 1,349; Victoria 871; Tasmania, 566; and Northern Territory, 110.

Western Australia vessels and equipment were valued at $16,065,000; Queensland $14,597,000; South Australia $11,024,000; N.S.W. $8,905,000; Victoria $7,051,000; Tasmania $6,705,000, and Northern Territory $6,135,000.

Value of Vessels Rises

There has been a gradual decline in vessels since 1964/65, when 9,426 were registered. In 1967/68, the total increased to 9,354; it dropped again to 9,244 in 1969.

However, the value of boats and equipment increased from $40,041,000 in 1964/65 to $56,601,000 in 1967/68; it reached US$70,419,000 in 1968/69.

Thirty-three boats operated in the pearl shell and trochus shell fisheries. Three whale chasers operated from one shore station in Western Australia.

Queensland was the only State with vessels listed at 100 ft. and over (9). The largest number was in 20-ft. and under 30-ft. bracket. In this category, South Australia had 1,851; New South Wales 1,690; Queensland 471; Victoria 252; Tasmania 99, and Northern Territory 37.

Western Australia registers its boats under different classifications. There were 50 boats 55 ft. and over; 205 35 to 55 ft.; and 346 over 25 ft. and under 35 ft.

People

In 1968-69, 16,460 persons worked in general fisheries, compared with 14,965 in 1967-68, and 11,414 in 1964-65.

In 1968-69, south Australia had highest number--4,361; New South Wales had 3,471; Western Australia 2,785; Queensland 2,539; Victoria 1,571; Tasmania 1,160; and Northern Territory 573.

In 1968-69, another 1,425 persons worked in edible oyster industry, compared with only 997 in 1964-65 season. In pearl and trochus shell fishery, there were 473 people, compared to 997 in 1964-65.

Whaling had changed only slightly: 48 working at sea in 1969, compared with 45 in 1964-65; 32 on shore against 38 for same periods. ('Australian Fisheries', Sept. 1970.)

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Holiday Greetings

from the

National Marine Fisheries Service